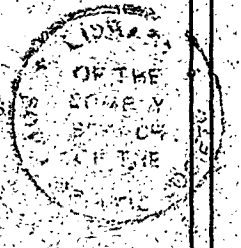
Report of the Haffkine Institute

For the Year 1930

BY

MAJOR L. A. P. ANDERSON, I.M.S.

Offg. Director, Haffkine Institute



[Price—Annas 6 *or* 8*d*.]

BOMBAY

PRINTED AT THE GOVERNMENT CENTRAL PRESS

1932

Obtainable from the Superintendent, Government Printing and Stationery, Bombay, or through the High Commissioner for India, India House, Aldwych, London, W.C.2, or through any recognized Bookseller

BOMBAY BRANCH
OF THE
Royal Asiatic Society.

Digitized with financial assistance from the Government of Maharashtra on 11 July, 2017

CONTENTS

	Page
Frontispiece—Waldemar Mordecai Wolff Haffkine.	
Staff	1
Waldemar Mordecai Wolff Haffkine	3
General Review	8
Haffkine's Plague Prophylactic Vaccine	14
Examination of Rats for Plague	16
Pharmacological Unit	17
Biochemical Unit	19
Department of Public Health Chemistry and Bacteriology	21
Antirabic Department	22
Vaccine Department	23
Diagnostic Department	26
Pathological Section	28
Special Researches financed by the Indian Research Fund Association—	
Anti-plague Inquiry	30
Maternal Mortality Inquiry	38
Tuberculosis Inquiry	39
List of Papers published during the year	42
Appendices—	
Tables I to XIII	44-76

WALDEMAR MORDECAI WOLFF HAFFKINE

BORN: 16TH MARCH 1860. DIED: 26TH OCTOBER 1930.

FIRST DIRECTOR OF THE HAFFKINE INSTITUTE.

1896—1904.

REPORT OF THE HAFFKINE INSTITUTE FOR THE YEAR 1930

STAFF.

Director.

Brevet-Col. F. P. Mackie, K.H.S., O.B.E., M.D., M.Sc., D.P.H., F.R.C.S., F.R.C.P., I.M.S., from 7th November to 31st December 1930.

Major L. A. P. Anderson, M.A., M.D., B.Chir., D.P.H., D.T.M. & H. (Cantab.), F.Z.S., I.M.S., Officiating Director from 1st January to 6th November 1930.

Assistant Directors.

Major S. S. Sokhey, M.A., B.Sc., M.D. (Edin.), D.T.M. & H. (Eng.), I.M.S., in charge Biochemical Unit.

Mr. S. N. Gore, L.M. & S. (Bom.)

Supernumerary Officer.

Major W. J. Webster, M.C., M.B., D.T.M. & H. (Eng.), I.M.S., Supernumerary Officer from 1st January to 30th August 1930.

Pharmacological Unit.

Rev. Father J. F. Caius, S.J., F.L.S., M.S.C.I. (Paris).

Dr. K. S. Mhaskar, M.A., B.Sc., M.D., D.P.H., D.T.M. & H.

Biochemical Unit.

Mr. M. A. Malandkar, M.A., M.Sc.

Mr. S. K. Gokhale, B.A. (Hons.), M.Sc., A.I.I.Sc.

Antirabic Department.

Military Assistant Surgeon H. M. La Frenais, I.S.O., I.M.D.

Mr. R. K. Gokhale, S.M.S.

Antiplague Inquiry.

Dr. B. P. B. Naidu, M.D. (Edin.), M.H., D.P.H., D.T.M. (L'pool).

Dr. J. H. Wadia, B.A. (Hons.), B.Sc. (Bom.), Ph.D. (Cantab.).

Mr. H. S. Billimoria, M.B., B.S., D.T.M. (L'pool). Acted as Officer in charge Maternal Mortality Inquiry from 11th June 1930 to 2nd October 1930.

Dr. K. H. Kamakaka, M.B., B.S., M.R.C.P., D.P.H., D.T.M., D.O.M.S.

Mr. R. G. Sathe, Veterinary Surgeon.

Inquiry on Maternal Morbidity and Mortality in Childbirth.

Dr. Margaret Balfour, C.B.E., M.D.

Dr. Lucy Wills, M.D.

Dr. M. M. Mehta, Ph.D., D.Sc. (Lond.), from 1st January to 10th June 1930.

Mrs. S. K. Talpade, M.B., B.S.

Tuberculosis Inquiry.

Dr. M. B. Soparkar, B.Hy., M.D. (Bom.).

Jamadar C. S. Dhilon, I.M.D.

Additional Research Worker (Voluntary).

Dr. P. M. Wagle, M.B., B.S. (Bom.), D.B. (Manch.), D.P.H. (Lond.), D.T.M. (Liv.).

Medical and Scientific Assistants.

Rao Bahadur G. D. Chitre, L.M. & S., B.M.S. (Plague Research).

Mr. N. P. Dalal, M.B., B.S., D.P.H., D.T.M. & H. (Eng.), B.M.S. (General Diagnostic Department).

Mr. J. P. Menezes, M.B., B.S., B.M.S., 13th January to 31st December 1930.

Mr. T. G. Akula, S.M.S. (Morbid Histology and Malaria).

Mr. K. H. Bharucha, B.A., B.Sc. (Public Health Chemistry).

Chief Technical Assistants.

Mr. J. Petty—(Plague Vaccine).

Mr. A. Petty—(Plague Vaccine).

Mr. J. Mallett—(Plague Vaccine).

Mr. R. D. Panwalkar, A.M.—(Artist and Photographer).

Mr. H. J. Parelkar—(Engineer).

Mr. Shaik Mahomedally—(Senior Media Maker).

Office Staff.

Mr. F. R. Mistri—Head Clerk.

Mr. G. G. Subnis—Accountant.

Mr. D. W. Shirgaokar—Storekeeper.

Mr. D. N. Mhaskar—(Packing).

Junior staff, subordinates and menials number 118.

The Late Professor W. M. HAFFKINE, C.I.E., Sc.D. (Odessa), The First Director of the Haffkine Institute.

It was with profound regret that Reuter's message from Lausanne announcing the sudden death of Mons. Haffkine on the 26th October 1930, was received at this Institute.

The Haffkine Institute, which owes its present activities to his genius, and the Grant Medical College, which had been the scene of his early researches on plague, were closed down on the 27th of October to pay homage to his memory. Obituary notices have appeared in all our local newspapers and in the medical journals of other countries and these have acclaimed him as one of the greatest benefactors of mankind. India has special reason to bemoan his loss; he had spent the best years of his life here fighting against the scourges of cholera and plague; he has saved many of her people from the ravages of these two diseases by his prophylactic inoculations. Although he had retired from the service towards the end of 1914, still his interest in India and her people had remained unabated, and he was in communication with some of his Indian friends until his death.

Haffkine was born during a period of great scientific discoveries which had greatly influenced his career. In the middle of the 19th century, Odessa was one of the most important sea-ports of Russia. The general aspect of the city was that of a wealthy West-European port. It was the real capital, intellectual and commercial, of so-called New Russia; it was also the chief educational centre, with a University containing over 1,700 students. It was in such an atmosphere that Waldemar Mordecai Wolff Haffkine was born on the 16th of March 1860. Although a Russian by birth he was of Jewish race. His parents were in affluent circumstances and he, therefore, received his early classical education at the Berdiansk Gymnasium; thence, he proceeded to the University of Odessa where he graduated in the Science Faculty in 1884. For the next four years he was engaged as a research worker at the Zoological Museum of his native town.

Circumstances of parentage and residence in the great cosmopolitan city of Odessa combined with his great intellectual capacity made Haffkine a profound scholar, an accomplished linguist and a marked man of science even at this early period of his life. In 1888, he was appointed as the Assistant Professor of Physiology in the University of Geneva and discharged his professorial duties in the Swiss Medical School.

Pasteur's fundamental discovery of protective inoculations with vaccines against chicken cholera, against anthrax and against rabies gave an immense impetus to this line of research at the Pasteur Institute, Paris.

In 1883 Koch had made the important discovery of the comma bacillus and isolated it from the dejecta of patients suffering from cholera and in 1884 he established its causal relationship with that disease. In 1885 Ferran attempted protective inoculation against cholera in Spain; he prepared his vaccine from cultures of cholera microbes isolated from human cases and grown in liquid media; this he injected into men.

A study of the numerous data published by Ferran failed to produce conviction in the efficacy of the treatment employed by him and the question remained open. It was in an atmosphere such as this that Haffkine came to Paris in 1889 to work under Pasteur. Under the able direction of Pasteur he began his researches to discover a method of preparing a vaccine which would protect the body against the poison elaborated by the comma bacillus. The problem in the preparation of a vaccine against cholera was to find the means of fixing a virus of a well defined strength. This Haffkine accomplished by cultivating the cholera microbe in the animal body and maintaining its virulence by successive passages in such animals. Thus, he was not only able to produce with certainty a specific infectious disease in animals but with cultures of increasing virulence he was able to protect them also. He now possessed a vaccine which would protect animals against a fatal disease caused by the cholera bacillus. He next established the harmlessness of the vaccine by very careful and patient observations on medical men and scientists whom he inoculated. He was anxious to test the efficacy of his vaccine in human beings in those localities in which the disease starts periodically in epidemic form to invade other countries. With this end in view he was planning a visit to Siam. But a happy circumstance brought him into contact with Lord Dufferin, the British Ambassador in Paris. Dufferin had already heard of Haffkine's researches on cholera ; as he had been the Viceroy of India he knew that India had long been regarded as the home of cholera and he therefore took great interest in the matter and wrote to the Secretary of State for India and to Lord Lansdowne, the then Viceroy, to give facilities for Haffkine to prosecute his further researches on cholera in India. With several letters of introduction Haffkine visited London and explained his theory of prophylactic inoculation against cholera and demonstrated his technique in a series of lectures at Netley and at the laboratories attached to the Examination Hall of the English Conjoint Board. He arrived in Calcutta in March 1893 on his voluntary mission and set himself to work immediately. He chose Bengal as being the most important part of the country affected by cholera for commencing his preventive treatment.

The first problem which he had to solve was to familiarise the people of the country with his system of treatment and everything relating to it, as he had to have the consent of the person to be operated upon or that of his friends. The inhabitants of the northern part of India were the first to come forward to submit themselves to the inoculation while all attempts to apply them to Lower Bengal were in the beginning frustrated. In the course of the first year 22,703 people were inoculated in the North-West Provinces and Oudh and in the Punjab ; this included all classes of the population.

In the second year it became possible to direct his operations to those parts of the country where cholera always prevails and where the method could be subjected to the required test. From March 1894 to July 1895, 19,473 persons were inoculated in some of the most affected localities of India. The results indicated that in inoculations a valuable means of assisting in combating cholera epidemics was available.

On the eve of his leaving India owing to his ill-health, Haffkine submitted a report on Anti-cholera Inoculation to the Government of India dated the 25th August 1895 in which he stated that " on regaining my health it is my intention to contribute to this object every means in my power. With the approval of the Government of India, I would like to revisit this country." On his return to Europe, Haffkine paid a visit to Professor Koch and recapitulated to him the data of his report to the Government of India and said that he felt it necessary to do all in his power to confirm his results by new observations. Professor Koch told him that the demonstration was already complete. He believed the protective power of the method was established and the main question was solved by the facts recorded in the report. Haffkine subsequently visited London and delivered a lecture, on the results of anti-cholera inoculation in India in the Examination Hall of the Conjoint Board of the Royal Colleges of Physicians and Surgeons in December 1895, which he concluded in these words : " Mr. Chairman and Gentlemen, on the day when I came back from my expedition to India, I found my former chief, Mons. Pasteur, lying on his bed of death. Whatever might have been his appreciation of the work done in India, there can be only one desire on my part, that all the honour for the results which may possibly come out of my efforts, should be referred to him, to his sacred memory."

In the course of a few years from the commencement of the anti-cholera inoculations in India, a large number of authoritative reports have been published pointing to the efficacy of inoculation in reducing both the attack rate and the case mortality of the disease ; and in view of the immense popularity of anti-cholera inoculations all over India, and the very great demands made for the vaccine, every laboratory in India is now manufacturing this vaccine. Enormous quantities are sent out every year from the Central Research Institute, Kasauli, while the Public Health Department of Bengal has a special laboratory in Calcutta for the sole manufacture of this vaccine.

The results obtained by anti-cholera inoculation were so encouraging that the tea-planters in Assam invited Haffkine to visit the tea-gardens to operate on their coolies and the Government was induced to help him financially. Haffkine returned to Calcutta in 1896 and began his further researches. While he was thus engaged, bubonic plague broke out in an epidemic form in the city of Bombay.

The Government of India, thereupon, sent Haffkine to Bombay with instructions to investigate the cause of the outbreak and to devise if possible some method of dealing with this new and terrible disease, similar to that which had so impressed them in the case of cholera. He reached Bombay on the 7th of October 1896, and the very next day began work in a room in the Petit Laboratory of the Grant Medical College. His laboratory consisted of one room and a corridor and his staff of one clerk and three peons or messengers. It was here that he made the discovery of the stalactite growth assumed by the plague bacillus when grown in nutrient broth. In December 1896, Haffkine was successful in protecting rabbits against an inoculation of virulent plague bacilli, by treating them

previously with a subcutaneous injection of a broth culture of these organisms sterilised by heat. The rabbits treated in this way became immune to plague. On the 10th January 1897, Haffkine caused himself to be inoculated with 10 cc. of a similar preparation thus proving in his own person the harmlessness of the fluid. Shortly after this various medical men and prominent citizens of Bombay were publicly inoculated to encourage others to submit to the operation ; but it was not till the publication of the result of inoculating half the prisoners in the House of Correction at Byculla, Bombay, where plague had broken out that the measure became popular. Increased popularity of inoculation involved more wholesale manufacture of the prophylactic and this in turn necessitated the removal of the laboratory to the " Cliff " bungalow, Malabar Hill, lent by the Municipality of Bombay. The Bungalow had been used only for seven months when a second move had to be made to another bungalow in the Napean Sea Road. At this time, H. H. Sir Sultan Shah, Aga Khan, K.C.I.E., the head of the Khoja Mussalman community, who had been early convinced of the efficacy of inoculation, fitted up at his own expense " Khushru Lodge " one of his bungalows in Mazagon, for Haffkine's use. The staff under him was again increased. The laboratory remained there for more than a year, but in March 1899 the demands for the vaccine from all parts of the world became so pressing that more accommodation was an urgent necessity. This was found in the Old Government House at Parel.

On the 10th of August 1899, this building was formally opened by H. E. Lord Sandhurst, Governor of Bombay, as the Plague Research Laboratory, under Haffkine as its Director-in-Chief. The Indian Plague Commission visited India during 1898-1899. The composition of Haffkine's plague prophylactic was subjected to searching enquiry by the Commission, who pronounced its employment to be free from danger and that it was used on a large scale in various parts of India without producing injurious effects. With each year the conviction as to the value of prophylactic inoculation against plague grew more and more.

Plague made its first appearance in an epidemic form in the Punjab in 1897 and every successive year saw fresh outbreaks. In 1901 the disease assumed very great proportions. It was, therefore, decided that before the next outbreak intensive anti-plague inoculation should be carried out throughout the Punjab and as a result of this the demands for large supplies of the vaccine became incessant. It was at this time that what is officially described as " the Malkowal disaster " took place.

In November 1902, nineteen persons who were inoculated with the prophylactic developed tetanus and all of them died. A Commission was appointed to enquire into this by the Government of India. This Commission found that the germs of tetanus had been introduced into the prophylactic fluid before the bottle was opened at Malkowal and they thought it probable that this might have occurred owing either to insufficient sterilisation or to the process of filling the bottle from a large flask having been performed with defective precautions. They also expressed the opinion that carbolic acid was a valuable agent in restraining tetanus growth when added to the plague prophylactic and they, therefore,

thought that its omission was a grave mistake. The findings of this Commission were referred to the Lister Institute, who reported that in all probability tetanus was at the time of inoculation present in the fluid contained in the bottle, but that it was impossible to determine at what stage in its history or in what way the bottle became contaminated.

Haffkine throughout maintained that the vaccine sent out from the laboratory was not contaminated with tetanus germs and that the contamination must have taken place outside the laboratory; it came out in the evidence of Dr. Elliot, who carried out the inoculations at Malkowal, that the cork of the vaccine bottle dropped on to the ground when the bottle was opened and was replaced, and this might well have explained how the vaccine became contaminated.

This enquiry lasted for some considerable time, and throughout Haffkine bore it with great fortitude; but it was a heavy strain. He left Bombay on the 30th April 1904 on a year's leave pending the final decision of the Government. He was relieved of his post as the Director-in-Chief of the Plague Research Laboratory and he remained unemployed. During his absence from India, Haffkine spent a most anxious time visiting the famous laboratories of Europe and placing his contentions before several unprejudiced, scientific men and eminent bacteriologists who unanimously exonerated him from all blame.

In 1907, Haffkine received through the India Office a communication from the Secretary of State recording a view favourable to him in the case of the Malkowal disaster and offering him terms of re-employment in India. Congratulations poured in from all quarters at this decision of the Secretary of State. After much persuasion he finally accepted the post of the Director-in-Chief of the Biological Laboratory at Calcutta. In the same year, he was awarded the distinction of C.I.E.

He returned to India, however, a broken-hearted and a disappointed man. He now sought seclusion and obscurity until he retired towards the end of 1914 and took up his permanent residence at Boulogne-sur-Seine.

Twenty-eight years have now rolled by since the Malkowal disaster; successive attempts have been made to improve upon the original method of manufacturing Haffkine's plague prophylactic, but these have only resulted in essentially adhering to his original method. Experiments carried out in India and elsewhere have demonstrated the superiority of Haffkine's prophylactic to other types of plague vaccines. Although the incidence of plague in India has been on the decline yet the demand for the prophylactic vaccine has been steadily on the increase. Since its introduction as a prophylactic measure, during the past 34 years no less than 33,391,339 doses have been sent out of the laboratory. The reception of inoculation has undergone a profound change in India. Where riots were liable to occur when inoculation was pressed, recently a riot was threatened because the supply of the vaccine ran short. No further testimony is needed to prove public recognition of its efficacy as a protective measure against plague.

Great as was the genius of Haffkine, greater still was his personality; not unlike Pasteur, he was a man full of modesty and very considerate

to his adversaries. At the Haffkine Institute, there are still some who had been associated with him and his work since the beginning of his plague operations in Bombay ; one and all acclaim him as a generous, kind and sympathetic master and a good friend in need. It is a fitting tribute that at the instance of Bt.-Col. F. P. Mackie, I.M.S., the Director of this laboratory, the Bombay Government have renamed it the Haffkine Institute to perpetuate the memory of one who has conferred on India and its people incalculable benefits. When Mons. Haffkine was informed of this, he wrote as follows : " I am very greatly indebted to Col. Mackie for the name given to the Parel Laboratory and to you for the terms in which you have written to me. Very much do I appreciate also your mentioning of the friendly attitude towards me of the other members of the Institute's staff. The work at Bombay absorbed the best years of my life and I need not explain how much I feel everything connected therewith. I wish the Institute prosperity as an active centre of work on behalf of the health organisation of the country and I send blessings to the whole of its staff."

B. P. B. N.

General Review.

Plague.

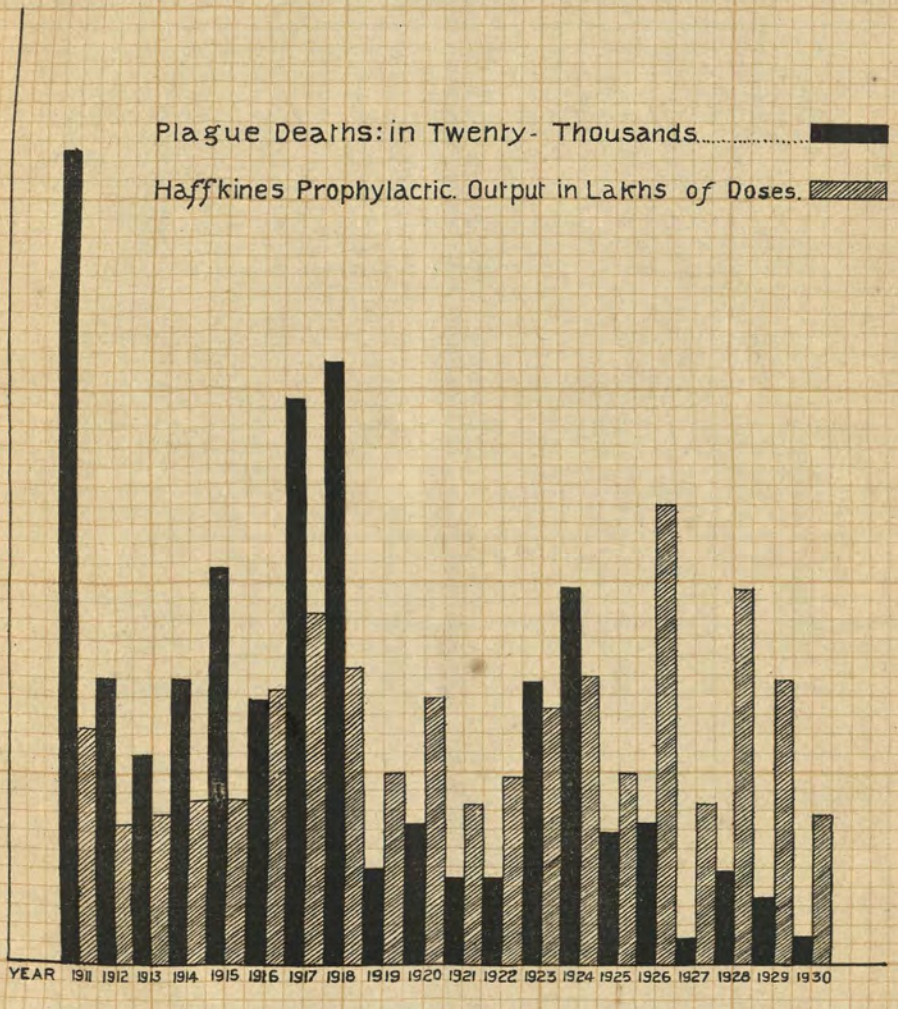
1. *Plague Vaccine.*—The demand for plague vaccine during the year under review was little more than half the previous year's output, and is the lowest since 1912. This reduced output of vaccine directly reflects the remarkably low incidence of plague, which during 1930 was the lowest recorded in India since the disease first assumed a serious aspect in this country.

Although the actual demand for plague vaccine in the year 1912 was less than that for the present year, the reported deaths from plague during that year were nearly 13 times as numerous as those recorded in 1930. If the recorded deaths are regarded as an indication of plague incidence, that is, assuming that the general case mortality has not varied materially during past years, a comparison of the annual output of plague vaccine with the recorded deaths from plague shows clearly that the number of doses of vaccine now issued in relation to the incidence of plague is very much greater than in past years. Thus, in the year 1912, referred to above, for each recorded death from plague only 2·3 doses of vaccine were issued. In 1930 the corresponding figure was 32 doses. Over the past quinquennium the figures are—16·7 (1926), 29 (1927), 21 (1928), 23 (1929) and 32 (1930). In the quinquennium 1911–1915 the figures were—1·4 (1911), 2·3 (1912), 3·6 (1913), 2·7 (1914), 1·9 (1915).

These figures make strong evidence of the increasing recognition that the value of this preventive measure is receiving from the health authorities and the public.

The accompanying graph shows the annual output of vaccine in relation to the incidence of plague and further demonstrates how closely the former has followed the latter during the past ten years.

Plague and the Output of Haffkine's Plague Prophylactic.



G.P.Z.O. Poona, 1932.

2. *Researches in connection with plague vaccine.*—Dr. Gore has continued working on the cultural reactions of *B. pestis*, and has further elaborated certain tests for the detection of contaminants in, and the preservation of the purity of the seed broth cultures. As a result of many years experience he finds that no method is yet available for preventing with certainty the occasional appearance of contaminants in the seed, but by the use of various tests their detection is assured.

Major Sokhey and Dr. La Frenais have continued their important work on the standardization of Haffkine's Prophylactic. They have now thoroughly investigated the four important variables on which any method of biological standardization must depend. The details of this basic work are given in the body of this report. Here it may be said briefly that a satisfactory standard test virus has been determined and maintained, that experiments so far as they have gone indicate that the laboratory bred white mouse is the animal of choice for this work, that an interval of 10 days is desirable between vaccination and inoculation of the test virus to allow of the development of immunity and that the dose of vaccine used in previous tests, namely $\frac{1}{2}$ cc. can desirably be reduced to 1/16 cc. while still producing absolute immunity. The work is still proceeding with a view to elaborating a standard immunity test in the light of this experience.

A critical investigation has been undertaken to settle the long standing controversy regarding the relative value as a prophylactic of Haffkine's broth vaccine and a vaccine prepared from growth of *B. pestis* on solid media. It has hitherto been believed in this Institute, as a result of numerous experiments and much practical experience that Haffkine's vaccine is superior, in spite of its disadvantages of large dosage and severe reaction. With the elaboration of a reliable means of evaluating the immunity conferred by different vaccines it is now possible to submit this question to more precise inquiry and work on these lines is approaching completion.

In connection with the general question of standardizing Haffkine's Prophylactic Major Sokhey and his assistants in the Biochemical Department have carried out important chemical studies on the broth medium used in the preparation of the vaccine. These are reported in the section dealing with the work of the Biochemical Unit.

3. *Parasitology and Transmission of Plague.*—This inquiry, under the auspices of the Indian Research Fund Association, was continued on the same lines as last year, until Major Webster proceeded on leave in August 1930. Among their more important results the following may be mentioned: (1) *X. brasiliensis* has been shown to be a particularly regular transmitter of plague under experimental conditions, and capable of maintaining a continuous transmission experiment throughout the year under certain conditions; (2) starved infected *X. astia* were found capable of restarting an epizootic among rats after intervals of 3 to 7 days.

An attempt to carry out with *Pulex irritans* transmission experiments similar to those recorded with the three species of rat flea, met with the initial obstacle that no satisfactory supply of laboratory bred fleas of

this species could be obtained by any method of breeding hitherto tried. Major Webster calls attention to the caution necessary in dealing with this particular species.

A series of experiments was carried out to determine the value of various substances reputed as flea repellants.

The marked differences in the character of the fæces of rats fed on different diets was called attention to by Dr. E. R. Pierce, Assistant Port Medical Officer, Liverpool, in a paper appearing in "The Medical Officer" of 17th May 1930. At the request of the Port Health Officer, Bombay, Dr. Chitre carried out a series of observations which in essentials confirmed Dr. Pierce's findings.

Drs. Gore and Chitre in collaboration determined the extreme period after death of plague infected rats within which plague infection could be detected in the decomposing bodies. They arrived at the important conclusion that in the climate of Bombay, during September and October, a negative finding two days after death of the animal did not exclude the possibility of the death being due to plague.

4. *The Treatment of Plague.*—(*a*) *Anti-plague Serum.*—Dr. Naidu and his assistants have devoted most of the year under review to the preparation on a large scale of their curative serum, details of which were reported last year.

A most important trial of the serum in human cases under carefully controlled conditions was carried out and is reported in some detail later on in this Report. While the number of cases available for trial was unfortunately too small to permit of definite conclusions, the results were more than encouraging and it is hoped to institute further trials on a larger scale during the next plague season.

(*b*) *Chemotherapy of Plague.*—Rev. Father Caius and Dr. Wadia continued their work on this problem on the same lines as last year and have further investigated the twelve halogenomercuriphenols prepared by them.

The "safe dose" of these drugs for rabbits was determined and some of them were tried in the treatment of plague infected animals. They regard their results as encouraging.

The Pharmacological Unit.

A very valuable contribution made this year by Father Caius and Dr. Mhaskar to the Indigenous Drugs inquiry has been the examination of Indian plant remedies of reputed value in snake-bite. No less than 498 drugs, the product either of individual plants or combinations, administered in multifarious ways, were investigated. All were without effect in animals injected with a lethal dose of venom. It is believed that this investigation has covered all the reputed remedies for this condition which an exhaustive search of the literature has been able to reveal, and which are likely to be introduced in the form of proprietory preparations for many years to come.

The investigation of the indigenous medicinal drugs has continued steadily throughout the year and a report of this work has been published in the Indian Medical Research Memoirs.

Work on scorpion venom has been hampered by what appears to be a somewhat illogical objection on the part of the Postal Authorities to the transmission of the living animals through the post.

The Biochemical Unit.

During the year under review Major Sokhey and his assistants have begun a valuable investigation by chemical methods into the composition of the standard broth used for the preparation of Haffkine's vaccine with special reference to the fractions used up by *B. pestis* in its growth and the substances elaborated by this organism during growth. This work was briefly referred to above when discussing vaccine preparation.

The bearing of this work on plague vaccine preparation is basic in nature. It should help to solve certain outstanding problems of considerable importance in this connection, namely, whether it is possible to reduce the present large dose, and the toxicity of the broth vaccine and whether an agar vaccine can be used instead of a broth vaccine.

Work on lines similar to that carried out last year was continued in regard to the anæmias, and the determination of normal standards for blood examinations.

The Antirabic Department.

During the year under review, ending 30th December 1930, 736 persons received a full course of treatment at the Institute as compared with 685 last year. It is very gratifing to note that no deaths from hydrophobia occurred among those cases, although they included numerous class IV cases. Whether this satisfactory result can be ascribed to the exclusive use of the Paris fixed virus, or to the use of vaccines which are more concentrated than have hitherto been used here, namely 5 per cent. and 2 per cent. vaccines, or to the complete disinfection of all wounds carried out in this Institute, it is not yet possible to say.

No cases of paralytic accidents have been observed as a result of using the more concentrated vaccine.

The modified treatment suggested at the Conference of Directors of Pasteur Institutes held in Calcutta in December 1929, has been used here and at the out centres since March 1st, 1930. Statistics, such as they are, from the out centres do not indicate any change in the mortality rate attributable to the new treatment *per se* but owing to the failure on the part of many centres to obtain an adequate percentage of health returns these statistics are of little real value, and relatively few of the 5,000 odd patients treated at the centres can be taken into consideration.

The new case cards devised by the Conference of 1929 have been in use for all cases since January 1st, 1930.

Inquiry on Maternal Morbidity and Mortality in Childbirth.

The progress of this inquiry has been hampered in the first place by numerous changes in the direction and personnel, and secondly by the fact that *post mortem* examinations were not obtainable. The inquiry was under the direction of Dr. M. I. Balfour from 1st January 1930 until 7th February 1930, when Dr. L. Wills assumed charge, until she also went on leave on 1st May 1930. During the absence of

Dr. L. Wills, the work was carried out under the direction of Dr. M. M. Mehta until she resigned her post on 10th June 1930. Dr. Bilimoria then assumed charge and the inquiry was continued with a reduced staff until 3rd October 1930 when Dr. Wills returned from leave and again took over the direction.

So far as evidence was obtainable on this point, there was no indication in the human subject of a specific infection such as was met with in rats in whom anæmia was produced by deficient feeding. That a dietetic deficiency, however, is closely associated with these severe anæmias seems strongly indicated, in the light of recent work done.

The monkey experiments begun last year have not yet given conclusive results, and the work is being continued.

Tuberculosis Inquiry.

Work on this inquiry has been continued throughout the year by Dr. Soparkar and his assistants. Certain problems which were under investigation last year have been further worked out with the result that our knowledge of many important points in connection with human and cattle tuberculosis in India is being steadily widened.

The question of the type of organism responsible for non-pulmonary tuberculosis in the human subject has been further studied, and a small number of cases from the Punjab were examined from this point of view. It will be recalled that last year Dr. Soparkar reported that a large percentage of cattle in this Province were infected with tuberculosis and that it might be expected that bovine infection of the human subject would be more likely to occur here. The indications are that this is the case.

An interesting discovery made by Dr. Soparkar during his work in the Punjab was that of a case of natural infection in a bovine animal with the human type of *B. tuberculosis* showing that under certain conditions infection of cattle from man may occur, contrary to what has generally been believed.

A preliminary survey of the prevalence of human tuberculosis was commenced in the Punjab and in Bombay Presidency, and a vast amount of material has been collected from various classes of the population. The inquiry is indebted to those officials whose cordial assistance made this work possible. The results of this survey are now being collated.

During the year work was also done on (*a*) the prevalence of tuberculosis among animals other than domestic cattle, with the co-operation of the Superintendent of the Zoological Gardens, Bombay, (*b*) the filtrability of the tubercle bacillus, (*c*) spontaneous tuberculosis in laboratory animals and (*d*) cultural studies of the tubercle bacillus.

The Serological Relationship of the R & S variants of B. aviseptícus

An investigation of this problem was begun about the middle of the year by Dr. P. M. Wagle, a voluntary research worker at this Institute. The work this year was largely preliminary, and consisted chiefly in obtaining and maintaining in pure strain the two variants and in preparing their respective immune sera.

Difficulty was encountered owing to the constant tendency of the variants to revert to an intermediate type, and much delay occurred before a method could be determined of keeping the variants pure for the purpose of serum preparation.

Preliminary cross-agglutination tests have been carried out, which have not so far indicated any definite serological differences between the two variants except that the R variant is a stronger agglutinator than the S variant, even with the S serum. The work is continuing.

The Indian Research Fund Association.

Every year the valuable assistance given by this Association to the research work of the Institute is acknowledged in this Report.

The year 1930 has been no exception and again we express our gratitude for the active support which has been afforded us.

The major inquiries on Plague, Tuberculosis and Maternal Mortality have all been financed on a generous scale by this Fund.

Honours and Rewards.

Among the Birthday Honours the following appointment, and title, were conferred on members of the Institute Staff by H. I. M. The King-Emperor and His Excellency the Viceroy respectively:

(1) To be Companion of the Imperial Service Order—Military Assistant Surgeon, H. M. La Frenais, I.M.D.

(2) Rao Bahadur—Mr. G. D. Chitre, L.M. & S., B.M.S.

The Social Life of the Institute.

The Critics Club.—This Club has now been in existence since 1924 and has provided a useful medium for the encouragement of social intercourse between the members of the various departments of this Institute. At its periodical meetings which are predominantly social and informal, papers dealing with the work carried out in the Institute are presented for criticism and free discussion by the members.

The activities of the Club during the year were:

(1) A paper on the "Experimental production of Anaemias in laboratory animals fed on diet deficient in some vitamins" by Wills. (2) A social gathering to bid farewell to Major Anderson, the Acting Director, on the eve of his departure to England and to welcome Col. Mackie, the Director. (3) A meeting to consider membership to the club and of admitting additional members to the Critics Tennis Club. (4) A short summary on the work carried out by Naidu at Hyderabad with the locally prepared anti-plague serum by Mackie. (5) A synopsis of work done in connection with the antigenic properties of the rough and smooth type of *B. avisepticus* by Wagle. (6) The disinfection of wounds and the intensive treatment given to patients bitten by rabid dogs belonging to classes III and IV. (7) An "At Home" to Col. and Mrs. Mackie on the eve of their departure to Shillong.

The Tennis Club.—Which is a branch of the Critics Club continued to flourish and the Annual Tennis Tournament was keenly contested

by the staff and provided a series of most enjoyable evenings. The special feature for the year was the presentation of the Mackie Cup for Tennis Singles, which remains as a permanent memento of the founder of the Club.

The Cricket Club.—This club has again enjoyed a successful season. Of the 21 matches played eleven were won, five lost and five drawn. The thanks of the club are due to those members of the Institute staff by whose help the ground has been gradually enlarged and put in order converting what was once a rough and stony field of coarse grass and weeds into a really good cricket ground.

The thanks of the acting director are due to his colleagues and the staff of the Institute for their whole-hearted co-operation and assistance ungrudgingly given him throughout his term of office.

Haffkine's Plague Prophylactic Vaccine.

1. *Manufacture.*—In the year under report there is a definite fall, owing to a general decline in the prevalence of plague and the absence of serious epidemic outbreaks.

From the opening of the laboratory to the end of 1930, a total of 33,391,339 doses has been issued. The output of the vaccine in quinquennial periods has been as follows :—

Years	Doses
1897–1901	2,867,041
1902–1906	3,455,537
1907–1911	3,584,262
1912–1916	4,567,366
1917–1921	6,667,894
1922–1926	7,202,636
1927–1930	5,046,603
	33,391,339

During the year 1930 the output was 773,510 doses, the number of doses of anti-plague vaccine despatched monthly during the past two years are detailed below :—

Month	*1929*	*1930*
January	217,554	94,074
February	265,347	125,982
March	74,094	51,330
April	33,697	25,870
May	3,876	6,408
June	4,404	1,464
July	85,440	19,176
August	176,160	68,436
September	201,852	67,992
October	155,496	107,616
November	178,236	100,752
December	91,218	104,410
Total number of doses ..	1,487,374	773,510

2. *Distribution.*—The geographical distribution of the vaccine in India and to places outside India during the years 1929 and 1930 is shown below :—

	Number of doses	
	1929	1930
British India.		
Bombay Presidency	347,920	123,206
Madras Presidency	51,792	68,940
Bengal, Bihar and Assam	43,050	5,368
United Provinces of Agra and Oudh	173,334	61,110
Punjab	200,646	16,164
North West Frontier Provinces	666	....
Central Provinces and Berar	57,750	16,236
Delhi Province	....	6
Burma	65,316	57,534
	940,474	348,564
Indian States.		
Kathiawar	7,224	....
Southern Maratha Country	135,612	26,100
Savantwadi	204	102
Baroda	2,142	102
Cutch	....	504
Hyderabad	100,818	135,276
Mysore	252,702	187,236
Travancore	9,024	....
Benares	1,266	504
Patiala	10,020	....
Faridkot	204	....
Jammu	1,500	300
Bhopal	102	....
Jaipur	204	1,002
Jodhpur	156	....
Indore	204	....
Darbhanga	150	....
Rampur	....	504
Sandur State	72	....
Gwalior	6	....
	521,610	351,620
Portuguese Territory in India	36	30
Countries outside India.		
Baghdad	....	70,134
China	3,498	2,802
Straits Settlements, Penang	504	....
Egypt, Cairo	21,252	....
London	....	360
	25,290	73,326
Total number of doses ..	1,487,374	773,510

Examination of Rats for Plague.

Rats received at the Institute from the Municipality during 1930.

Month	Alive	Dead	Total
January	23,268	38,309	61,577
February	21,485	32,477	53,962
March	20,695	32,890	53,585
April	20,598	31,929	52,527
May	16,613	26,671	43,284
June	16,555	26,419	42,974
July	18,264	26,243	44,507
August	16,468	28,856	45,324
September	12,689	40,980	53,669
October	12,523	36,512	49,035
November	11,921	36,828	48,749
December	13,170	36,935	50,105
Total ..	204,249	395,049	599,298

Examination of dead rats for plague during 1930.

Month	Dead rats examined	Plague infected rats	*Rattus norvegicus*	*Rattus rattus*
January	28,524	41	39	2
February	23,487	36	33	3
March	21,156	76	70	6
April	20,762	108	95	13
May	18,653	126	120	6
June	17,900	26	21	5
July	19,751	59	55	4
August	19,028	41	40	1
September	28,108	63	56	7
October	23,395	46	40	6
November	26,757	37	32	5
December	25,953	32	29	3
Total ..	273,474	691	630	61

Relation of human plague deaths to plague deaths among rats.

Month	Human plague deaths	Rats examined *post-mortem*	Plague infected rats	Percentage mortality
January	0	28,524	41	0·1
February	2	23,487	36	0·2
March	3	21,156	76	0·4
April	8	20,762	108	0·5
May	5	18,653	126	0·7
June	2	17,900	26	0·1
July	1	19,751	59	0·3
August	0	19,028	41	0·2
September	2	28,108	63	0·2
October	2	23,395	46	0·2
November	0	26,757	37	0·1
December	0	25,953	32	0·1
Total ..	25	273,474	691	0·25

Pharmacological Unit.

A. *Indigenous Drugs.*

1. Indian Plant Remedies used in Snake-bite were examined in the course of the year. In all 314 individual plants and 184 combinations were tested. We have every reason to believe that this work is exhaustive and we may safely *conclude* that *none of the Indian Plants hitherto recommended for the treatment of snake-bite has any preventive, antidotal or therapeutic effect.*

In his Presidential Address to the Pharmacological Section of the 21st All-India Ayurvedic Conference held in Mysore in December 1930, Dr. K. S. Mhaskar outlined the work carried on in this Laboratory and explained the special difficulties inherent in an enquiry into the properties of indigenous drugs ; difficulties which none but those engaged in that kind of research are able to realise.

Two papers in Sanskrit, dealing with the results achieved in the Pharmacological Laboratory at Parel, were circulated among the congressists and received with mixed feelings of surprise and gratitude : surprise at so many reputed remedies proving useless, gratitude for being told the truth. It is, indeed, a mistake to suppose that the craving for knowledge is the privilege of a few. Whatever their station in life men want information, facts, the truth more to-day than ever before.

The following resolution was passed at the Conference: " This Conference expresses its high appreciation of the Ayurvedic Research work made by Dr. K. S. Mhaskar, M.A., M. D., and Reverend Father J. F. Caius at the Pharmacological Laboratory of the Haffkine Institute, Bombay,

of which Dr. Mhaskar has given a demonstration here ; but they regret that the amount of work turned out seems far short of their expectations. This Conference offers to collaborate with the Government of Bombay through eminent Ayurvedists to advance such research work, and notes with regret that Dr. Mhaskar and Father Caius had to carry out the work practically single-handed for the last 14 years. This Conference therefore requests the Bombay Government to provide them with proper assistance and further facilities for Pharmacological and Chemical Research work on the same scale as provided in Calcutta. This Conference hopes that immediate effect will be given to its request in this connection."

Or, in the words of the Director of the Haffkine Institute in his Report for the year 1928 : " It is a matter of regret that the Pharmacological department is understaffed ".

2. " Therapeutic Notes on some Plants used medicinally in India " formed the subject of a paper read at the 8th Congress of the Far Eastern Association of Tropical Medicine, held at Bangkok, Siam, in December 1930. This was a summary of the results obtained with 348 Indian medicinal drugs, indigenous or imported, during the period beginning July 1917 and ending July 1930.

3. The chemical analysis of the bark of *Alstonia scholaris* R. Br. was undertaken and the hydrochlorides of the two alkaloids, ditamine and echitamine, prepared. We have found that of the two alkaloids echitamine is the only one to have a marked action in the treatment of dysentery.

4. Mangostin was extracted from the dried rind of the fruit of *Garcinia Mangostana* Linn. and tried clinically. It was found to be very inferior to the powdered rind as an antidiarrhœal agent.

5. The following were tried for their effect on the blood sugar content of rabbits :—*Hydrocotyle asiatica* Linn., and the leaves of *Melia Azadirachta* Linn.

6. The study of the composition of the bark of *Symplocos racemosa* Roxb. and its therapeutical value is in progress.

B. *Earth-eating and Salt-licking.*

Six samples of soil from Salt-licks in India and a medicinal earth from Socotra, were analysed.

C. *Scorpion Venom.*

The effects of a sting from *Buthus alticola* Pocock were recorded as being very mild, if anything.

Government Resolution No. 3260/28, dated the 28th October 1929, regarding the transmission of scorpions by post has greatly jeopardized this enquiry as, beyond transmission by post, we do not see any other

method by which scorpions could be readily and expeditiously forwarded to us.

It appears that in accordance with article 41 (*a*) of the Universal Postal Convention, Stockholm, 28th August 1924, it is forbidden to send by post "articles which *from their nature* or their packing *may expose* postal officials to danger ....." . Clause (*c*) of the same article forbids the despatch by post of "living animals except bees and silk worms." The attitude of the Post Office is that if there were no means of transport available other than the Post Office then in the interests of humanity it would not be defensible to decline to carry venomous insects by the post when by so doing scientific workers would be assisted ; but that it is not the case that scorpions cannot be conveyed in other ways ; and that, in the circumstances, the rule in clause 96 (6) of the Post and Telegraph Guide prohibiting the transmission of venomous insects by post cannot be relaxed.

Well, but what about bees ? They are venomous insects, and they surely can be conveyed in other ways than by post.

Anyhow, the amount of venom collected during the years 1928 and 1929 is sufficient to keep us busy through the greater part of 1931.

D. *Chemotherapy of Plague.*

Vide infra under Antiplague Inquiry.

Biochemical Unit.

1. *Some chemical Determinations on the Haffkine Prophylactic.*—Some of the problems in connection with the Haffkine Prophylactic (Plague Vaccine) that have interested us for sometime are—(1) whether it is possible to reduce the toxicity of the vaccine and the reaction resulting from inoculation ; (2) whether the dose of the vaccine can be reduced ; (3) whether agar vaccine can be used in place of the Haffkine Prophylactic. During the year under review, it was decided to use chemical methods to gain information on some of these points. Work done sometime ago in the Institute had shown that if the vaccine was allowed to stand, the bacterial bodies settled to the bottom of the flask and the clear fluid thus resulting, "supernatant fluid", was as effective in producing immunity against plague as was the whole vaccine. It seemed obvious that *B. pestis* during its growth in the liquid medium produced some soluble substance that had the property of conferring immunity. This substance was either a soluble protein resulting from the disintegration of the bodies of the bacteria themselves, or it was of the nature of an extra cellular toxin. During the year work was carried out to test the first hypothesis and fractional precipitation of proteins in the vaccines was carried out to isolate if possible the protein or proteins that conferred immunity.

The broth used for preparation of the Haffkine Prophylactic is made by the hydrolysis of mutton with hydrochloric acid, and the resulting

broth does not contain any heat coagulable proteins, i.e. proteins present are of the nature of albumoses and peptones. The method employed was fractional precipitation of these proteins with sodium sulphate and sulphuric acid into five fractions.

(1) First fraction, precipitated with 33 per cent. saturation with sodium sulphate—Primary albumoses, a mixture of proto and hetero albumoses.

(2) Second fraction, precipitated with 52 per cent. saturation with sodium sulphate—Deutero albumose A.

(3) Third fraction, precipitated with full saturation with sodium sulphate—Deutero albumose B.

(4) Fourth fraction, filtrate from 3 acidified to make one per cent. concentration of sulphuric acid—Deutero albumose C.

(5) Fifth fraction, or peptone, was determined by precipitation with tungstic acid.

The non protein nitrogen remaining in the filtrate from 5 was further fractionated into urea N, amino-acid N, creatinine N, and ammonia N. Nitrogen determinations after protein precipitations were done by a micro Kjeldahl method.

Three brews of the vaccine were examined after a growth of three days and thereafter at weekly intervals up to nine weeks. In every case *B. pestis* in its growth used up fractions 2 and 3. Fraction 5, peptone, was not used by the organism till after the fifth week. *B. pestis* also added to the liquid medium a heat coagulable protein—very probably an albumin. It is proposed to determine the value of this heat coagulable protein fraction.

These determinations also gave us an idea of the numbers of organisms present in the vaccine at the end of any particular period of growth. For example in one experiment at the end of three days growth, the insoluble bacterial bodies and heat coagulable material separable from the broth gave 2·1 mg. of N per 100 cc. of the broth and the number of organisms in the broth determined by colony counts was 104 millions. While at the end of six weeks of growth the same fraction gave 16·8 mg. N per 100 cc. of broth. If we assume that the weight of the organism is more or less constant, 16·8 mg. N would represent 832 million organisms—the viable organisms at this stage determined by actual colony count numbered only 16 millions. On the basis of this calculation a vaccine was made from a four days growth on a solid medium-agar. This vaccine showed in three experiments approximately as good immunising power as the plague vaccine made in liquid medium.

2. *Anæmias.*—Studies on anæmia were continued during the year and 26 cases were examined.

3. *Normal standards.*—At the conclusion of the work on normal standards for hæmoglobin and cell counts for Indians, estimation

of nitrogenous content of blood in normal adults was started and a complete study of 29 cases was made.

4. *Diseases of the kidney.*—A systematic study of kidney conditions was planned and four cases of nephrosis were examined.

Department of Public Health Chemistry and Bacteriology.

A. *Chemical Work.*

During the year under report 90 samples of water were examined chemically of which 47 were examined for their mineral constituents as well. The sources from which they were obtained and the extremes of variation in total solids and chlorine are shown in the table. The samples are grouped into three divisions, viz. surface waters, borings and wells, the first including rivers, lakes, tanks, reservoirs, jackwells and tap supplies.

Source	Number	Total solids		Chlorides		Potability	
		Highest	Lowest	Highest	Lowest	Fit	Unfit
Surface waters ..	41	480·0	7·6	228·0	0·5	1	40
Borings	33	544·0	32·4	220·0	3·8	4	29
Wells	16	440·0	33·4	123·0	3·6	*Nil*	16

Of the 90 samples examined only 5 were found to be chemically fit for potable purposes when judged by the standards laid down in English text books on Hygiene, though in fairness it must be said that these figures are not representative, as quite a number of samples may or may not be used for drinking purposes, and some were sent to be examined specially for boiler feed or purposes other than domestic.

Two samples of sewage effluents were examined.

B. *Bacteriological Work.*

Twenty-five samples of water were bacteriologically examined in respect of (*a*) the total number of ærobic bacteria per cubic centimeter of the water sample, and (*b*) the minimum quantity of the sample capable of producing acid and gas in MacConkey's bile-salt neutral red lactose broth incubated at 37°C. for two days.

Twenty-one of the samples were used for drinking purposes and only one of these was found to conform to the English standard for water bacteriologically fit for potable purposes.

Four samples of water from the Breach Candy Swimming Bath at Bombay were examined. All these samples generally conformed to the standard of bacteriological purity required for swimming baths.

One sample of sucrose was examined with respect to its suitability for use in investigating biochemical reactions of bacteria.

A copy, i.e. the sample of antiplague vaccine retained in the Institute, of a bottle of antiplague vaccine issued for inoculation was investigated as to its sterility and was found to be sterile.

The Department supplied staining and standard solutions, and rendered assistance in various ways from time to time in the routine work of the Institute.

Antirabic Department.

General.—This report covers the period from 1st January to 31st December 1930. It is gratifying to note at the outset that out of 736 persons who received the full course of antirabic treatment during the year in this Institute, none developed hydrophobia after the treatment, as can be seen from 88·3 per cent. of health returns received so far. It is probable that this is to be attributed at least as much to the thorough disinfection of wounds as to the modifications in antirabic treatment introduced this year, and supports the conclusion drawn in previous reports. Disinfection of wounds with formalin, pure nitric acid, and carbolic acid, irrespective of the time elapsed after bite, is justified as a routine measure and might well be made compulsory at the outcentres.

The antirabic treatment given in this Institute and its outcentres since 1st March 1930 is modified, and the 1 per cent. carbolised vaccine used previously has been discarded. The present modified antirabic treatment is as follows :—Class I cases receive 5 ccs. of 2 per cent. for 7 days ; Class II cases receive 10 ccs. of 2 per cent. for 7 days ; and Class III and IV cases receive 5 ccs. of 5 per cent. for 14 days. The Paris strain of fixed virus has been exclusively used this year for the treatment both at the parent institute and the outcentres.

The examination of this year's statistics of the outcentres, where thorough disinfection of wounds is not practised, reveals that the modified treatment and the introduction of the Paris strain have not *per se* reduced the mortality rate to any appreciable degree. The Paris strain shows no apparent advantage over the strains hitherto employed and it would be interesting to know what the experience of other Pasteur Institutes is with reference to its antigenic value. Whether the modified treatment should be continued or not can only be decided when the statistics for 1931 are available ; the statistics of the previous years from the outcentres are too unsatisfactory for comparison.

Another feature of this year has been the introduction of the case cards, adopted by the Calcutta Conference in this Institute and its centres from 1st January 1930. Every case that is treated is now accurately recorded, and detailed information is available for statistical purposes. The compilation of the case cards at most of the outcentres was at the start very unsatisfactory, but the majority of them have responded well to our repeated instructions. I would strongly urge Government to find

means to provide the outcentres with an adequate staff for the carrying out of antirabic treatments. Many complaints of insufficient staff have been received and unless a sufficiency of trained men are available for this work, it is not possible to obtain good results at the centres.

Health Returns.—The health returns received from persons treated at this Institute have been fairly satisfactory. As many as 88·3 per cent. of the returns have aleady been received and attempts are still being made to collect more. It is regrettable to have to observe once more that the outcentres have not come up to expectations. The returns from some of the outcentres are extremely poor, although several reminders have been sent for these returns. This failure, in some cases absolute, to collect returns, while partly due, no doubt, to insufficient staff, is also, one fears, due to lack of interest on the part of the authorities concerned and perhaps failure to appreciate the importance of this part of the work. The matter has, however, been brought to the notice of the Surgeon General and if no improvement takes place it may be necessary to recommend closure of the defaulting outcentres.

Treatment.—1,305 persons applied for antirabic treatment at this Institute; 736 persons completed the full course of treatment. 134 persons for some reason or other discontinued treatment. 435 cases were given advice but no treatment. The mortality rate amongst persons treated in this Institute has been *nil* this year.

Outcentres.—5,340 antirabic treatments were issued to the various outcentres. 5,006 persons received the full course of treatment; 530 discontinued treatment; 102 were given advice only. Out of this number 4 died of hydrophobia during treatment; 21 died within 15 days after completion of treatment; 30 died more than 15 days after the completion of treatment.

Veterinary.—161 antirabic treatments were issued to the various veterinary surgeons for treating dogs and other animals. The brains of 43 dogs and 1 other animal were received from Bombay City and the adjoining suburbs. In 20 there was no evidence of rabies; and in 24 brains Negri bodies were present.

Brains of 107 dogs and 3 other animals were received from various out-stations. Six brains were unfit for examination; in 27 there was no evidence of rabies, and 77 brains were found to contain Negri bodies.

Vaccine Department.

Plague—

3,590 brews of 1000 ccs. each were decanted.

130,901 bottles were filled with vaccine, labelled numbered and sealed.

9,254 bottles were tested for sterility.

947,782 doses of the prophylactic were in all sent to the Despatch Department for packing.

Antirabic vaccine—

859 brews were decanted.

57,694 bottles were filled :—

2,057 bottles of 25 ccs.
30,752 ,, ,, 10 ccs.
24,885 ,, ,, 5 ccs.

2,088 bottles were tested for sterility.

96,674 doses were sent to the Despatch Department.

Other vaccines prepared—

2510 ccs. Mixed T.A.B. Vaccine.

4885 ccs. Cholera Vaccine.

Killed Bacterial Emulsions prepared—

1100 ccs. *B. typhosus.*

600 ccs. *B. paratyphosus* A.

875 ccs. *B. paratyphosus* B.

150 ccs. *Micrococcus melitensis.*

375 ccs. *B. proteus* X 19.

Stock Cultures—

360 various stock cultures were subcultured at least once a month.

13 special cultures of *Pneumococcus* were subcultured on special media every 4 days. (Blood medium was prepared from time for the above cultures).

Miscellaneous work—

Decanting 5 flasks Glycerne Bile Peptone.
1 ,, Hydnocarpus oil.
4 ,, Bile.
6 ,, Carbolized saline.
7 ,, Anti-cholera vaccine.
3 ,, T.A.B. Vaccine.
1 ,, Typhoid Vaccine.
2 ,, Ascitic fluid.
3 ,, Peptone broth.
8 ,, Acid broth.
28 ,, Plague.
2 ,, Dead emulsion of *B. typhosus.*
1 ,, ,, ,, ,, *B. paratyphosus* A.
3 ,, ,, ,, ,, ,, B.
1 ,, ,, ,, ,, *B. proteus* X 19.
3 ,, Plague D 511, 512, and 513.
18 ,, Anti-virus.

Testing for sterility—110 bottles of various vaccines, etc.

Inoculation—230 persons were inoculated against plague.

Teaching—1 Medical man was taught the technique of plague inoculation.

	Number of Indents	Quantity supplied
Miscellaneous articles supplied		
Vaccines—		
Mixed T. A. B.	124	1,723 ccs.
Cholera	72	7,430 ,,
Chicken cholera	2	160 ,,
Dead emulsions—		
B. typhosus	42	368 ccs.
B. paratyphosus A	35	281 ,,
B	35	284 ,,
C	4	15 ,,
Culture Media—		
Blood Agar	13	95 tubes.

	Number supplied
Living Cultures—	
B. anthracis	2
V. cholerae	12
B. diphtheriae	3
B. dysenteriae Flexner	4
,, Shiga	4
,, ,, B. Y.	2
Micrococcus melitensis	4
B. pestis	27
B. typhosus	7
B. paratyphosus A	7
,, B	9
,, C	2
B. tuberculosis	2
Pneumococcus	2
Streptococcus	2
B. tetani	2
B. coli, B. prodigiosus, B. proteus Gonococcus, B. enteritidis Gaertner, B. dysenteriae, Sonne. *B. dysenteriae. Schmitz, B. morgan* No. 1, *Staphylococcus albus, citreus pyogenes aureus, B. pyocyaneus, B. aertrycke.*	1 each

	Number of indents	
Snake Venom—		
Cobra venom	3	57·2 grm.
Russell's Vipers' venom	1	10 ,,
Echis' venom	1	5 ,,
Black cobra	1	1 ,,
Spectacled cobra	1	1 ,,

Snakes—

24 cobras and 9 Russell's Vipers were received during the year; on an average 14 cobras and 11 Russell's Vipers were taken out fortnightly for extraction of venom and feeding.

Diagnostic Department.

(1) *By the General Diagnostic Department.*

Material examined	Positive	Negative	Total
A. *Blood.*			
(*a*) Films—microscopical examination—			
for malaria	4	38	42
,, microfilaria	..	1	1
,, differential leucocyte count	..	..	12
(*b*) Cultures—			
for plague	3	6	9
,, kala azar	..	1	1
,, other organisms (*B. typhosus* etc.) ..	..	..	26
(*c*) Serological examinations—			
Wassermann reaction (including 42 of cerebro-spinal fluid).	970	1,547	2,517
Kahn test	738	1,608	2,346
Blood grouping	..	..	22
Agglutination tests—			
for Enteric group	63	69	132
,, Undulant fever	..	4	4
B. *Sputum.*			
Microscopical examination for *B. tuberculosis* ..	6	18	24
Cultures for various microorganisms	..	..	15
C. *Urine.*			
General analysis	..	..	49
Cultures	..	..	86
D. *Faeces.*			
(*a*) Microscopical examination for ova, cysts, amoebae.	2	22	24
(*b*) Cultural examination—			
for miscellaneous organisms	..	..	23
,, cholera, typhoid, dysentery	9	21	30
E. *Cerebrospinal Fluid.*			
(*a*) Microscopical examination—			
for B. tuberculosis and other organisms ..	1	3	4
,, Cytological count	..	..	12
(*b*) Cultural examination	..	..	3
(*c*) Lange's gold test	..	..	2
F. *Miscellaneous Smear Examinations.*			
Swabs for *B. diphtheriae*	3	5	8
Pus for *B. tuberculosis*	1	7	8
Smears for *gonococci*	1	10	11
,, ,, *B. pestis*	2	12	14
,, ,, Leprosy	..	4	4
,, ,, Leishman-donovan bodies (*L. tropica*) .	..	1	1
,, ,, Trypanosomes (horse blood) ..	..	1	1

Material examined	Positive	Negative	Total
G. *Miscellaneous Cultural Examinations.*			
Swabs for *B. diphtheriae*	3	5	8
Nasal and throat discharges	..	..	4
Swabs from nose	..	..	3
„ „ throat	..	..	1
Teeth	..	..	2
Urethral discharge for *gonococci*	..	7	7
Pus for pyogenic organisms	..	..	47
Milk and barfi for organisms of food poisoning ..	..	2	2
H. *Miscellaneous Work.*			
Disinfectants for Carbolic Acid Coefficient ..	..	..	2
Post-mortem examinations various wild animals and birds.	..	..	12
Examinations of Rats for plague	..	6	6
Various pathological body fluids	..	..	5
Identification of cultures	..	..	17
„ „ snakes	..	..	6
„ „ mosquitoes	..	..	1
Van den Bergh test	..	..	1
Inoculation against Enteric fever	..	..	1
„ „ Diphtheria	..	..	10
Slides of *B. pestis* smears supplied	..	..	12
Group serum supplied	..	..	½cc.
Stock Curative Vaccines supplied :			
Gonococcus	..	..	50cc.
Staphylococcus	..	..	155cc.
Streptococcus	..	..	203cc.
B. pyocyaneus	..	..	1cc.
B. faecalis alkaligenes	..	..	10cc.
B. dysenteriae Flexner	..	..	10cc.
Autogenous Vaccines prepared	..	..	117

(2) *By the Biochemical Unit.*

(*a*) *Blood examinations*—	Number
Sugar	33
Non-Protein Nitrogen	25
Urea Nitrogen	25
Uric Acid	22
Creatinine	22
Chlorides	14
Cholesterol	15
Fatty Acids	1
Fibrin	5
Albumin	5
Globulin	5
Hæmoglobin	13
Cell volume	14
Van den Bergh	9
Calcium	2

	Number
(*b*) *Cerebrospinal fluid examinations*—	
Sugar	4
Globulin	4
Chlorides	4
Protein	4
Lange's Gold Test	5
(*c*) *Urine examinations*—	
General qualitative	24
Quantitative acidity	1
Sugar	19
Total nitrogen	9
Total Urea	5
Uric Acid	8
Chlorides	7
Albumin	4
Ammonia	1
(*d*) *Miscellaneous examinations*—	
Glucose tolerance test	4
Estimation of blood volume	1
Urea concentration test	2
Fat in fæces estimation	2
Occult blood in fæces	1
Analysis of fluids from tumours, cysts, etc.	5
Gastric analysis	13
Basal metabolism	26
Total	363

In addition, routine analysis of blood in anæmia cases under investigation, blood analysis of normal cases, adjustment of H ion concentration in media, etc., were done.

Pathological Section.

Table showing the total number of Pathological Tissues received and examined during the year 1930.

	Number
Non-malignant tumours	89
Malignant tumours	80
Tissues found to be normal	6
Miscellaneous pathological conditions	288
Received in a state unfit for examination	7
Total	470

Classification of Malignant Tumours and their Situation.

—	Carcinoma	Squamous Epithelioma	Sarcoma	Endothelioma	Basal Cell Carcinoma and Rodent ulcer	Total	Remarks
Lymphatic System.							
Axillary glands	4	..	..	..	..	4	Secondary growths.
Cervical glands	..	..	1	..	..	1	
Inguinal glands	..	..	1	..	..	1	
Respiratory System.							
Vocal cords	1	..	..	..	..	1	
Digestive System.							
Gums	..	1	..	..	..	1	
Tongue	..	2	1	..	..	3	
Tonsil	..	3	..	..	..	3	
Salivary glands	..	..	..	1	..	1	Mixed Parotid Tumour.
Omentum	1	..	..	..	..	1	
Rectum	1	..	..	..	..	1	
Anus	..	..	..	1	..	1	
Urinary Organs.							
Bladder	1	..	..	..	..	1	
Male Reproductive Organs.							
Prostate	1	..	..	1	..	2	
Testis	1	..	..	..	..	1	
Penis	..	4	..	..	..	4	
Female Reproductive Organs.							
Breast	10	..	..	..	..	10	
Ovary	2	..	..	1	..	3	
Uterus	1	..	..	..	..	1	
Cervix	2	6	..	..	..	8	
Vagina	..	1	..	..	..	1	
Labium	..	1	..	..	..	1	
Organs of Special Senses.							
Eye	1	1	1	..	..	3	
Ear	..	1	..	..	..	1	
Nose	..	..	1	..	..	1	
Skin and Subcutaneous Tissues.							
Face	..	3	..	..	2	5	
Lips	..	1	..	..	..	1	
Head and Neck	..	..	..	..	1	1	
Ankle	..	2	..	..	..	2	
Foot	..	3	..	..	..	3	
Connective Tissues and Muscles.							
Lower extremity ..	..	..	5	..	..	5	

	Carcinoma	Squamous Epithelioma	Sarcoma	Endothelioma	Basal Cell Carcinoma and Rodent ulcer	Total	Remarks
Bones and Joints.							
Head and Neck ..	..	..	1	..	..	1	
Jaws	..	..	2	..	..	2	
Ribs	..	..	1	..	..	1	
Pelvis	..	..	1	..	..	1	
Knee	..	..	1	..	..	1	
Tibia	..	..	2	..	..	2	
Total ..	26	29	18	4	3	80	

Anti-Plague Inquiry.

I. *Observations on the Cultural Characters of* B. pestis.

This study has been continued by Dr. Gore in extension of the work reported last year, and with special reference to the preparation of Haffkine's vaccine.

Human Strains of B.pestis.—During the year under report 589 Madras rats were used for the purpose of keeping up the virulence of six strains of *B.pestis* primarily isolated from the blood of human cases of septicæmic plague.

Heart blood of 311 passage rats was examined systematically by the procedure described at length in last year's report. In short, the procedure consisted in (*a*) collecting a drop or two of the heart blood in 1 cc. of citrated saline, (*b*) making four decimal dilutions by the loop-method and planting a one millimeter loopful from each dilution separately on rabbit blood agar slopes.

64 spleens of the passage rats from this series were also bacteriologically examined. A one millimeter loopful of the spleen pulp taken up from the cut surface of the spleen was emulsified in 1 cc. of citrated saline. On making four decimal dilution and planting as above, discrete colonies of *B. pestis* were secured in every case.

Preparation of the Seed used for sowing flasks of broth with B. pestis.—During the year under report sixteen plague seeds were prepared. It was again found that in order to secure cent per cent. purity of the seed, the use of one or more discrete colonies of *B. pestis* growing on the surface of blood agar sown with the heart blood of a passage rat was the best method. Experience has shown that no amount of precaution suffices to avoid the occasional appearance of contaminants in the broth culture from which the antiplague prophylactic is prepared, but reliable methods for their detection are now in routine use.

The three kinds of test elaborated in 1928 by Dr. Gore have been found adequate to determine the purity of the plague cultures.

Special Researches.

(1) *Method for inhibiting the spread of colonies of proteus bacilli.*—One 5-mm. loopful of a ten per cent. copper sulphate solution evenly spread on an agar slope made from the acid-meat-digest instead of bouillon as the base, was found not only to inhibit the spread of the colonies of proteus bacilli, but was found to enrich the surface of medium for the growth of *B. pestis.* Copper sulphate was first used by Allison and Ayling in 1929 for isolating diphtheria bacilli especially from aural pus which is known to contain proteus bacilli which render difficult the detection of the required organism without the assistance of an inhibitory agent.

(2) *Nitrate-reduction character.*—Last year it was reported that nitrite produced by the variants of *B. avisepticus* could be used for their differentiation. It is now found that the nitrite produced from a nitrate (potassium or sodium) e.g. when *B. pestis* is grown in Peptone water containing a nitrate, could be similarly used in the study of the course of variation occurring in this organism. The nitrite produced by such bacteria from a nitrate is much greater than that produced from the peptone. When nitrite is present in small quantities as when it is derived from peptone, 2-mm. loopful of Illosvay's reagent mixed with a 5-mm. loopful of the Peptone culture placed on an opal glass plate gives a definite pink colour. However, when the nitrite is derived from a nitrate, the pink colour immediately fades or changes to a yellow colour. In such a case the reversal of the proportion of the culture and the reagent suffices to give a definite colour which varies from a light to a deep pink.

(3) *Detection of Nitrite in the Heart Blood of plague-infected rats.*—The Nitrite test having been found very useful in the cultural identification of *B. pestis,* it was applied to a number of samples of heart blood of passage and street rats dying of plague. As a result of this preliminary study it was found that in several cases the citrate saline in which the heart blood of the rats was diluted, responded positively to the nitrite test. This subject is being further studied.

Papers on the above three subjects were submitted to the Medical and Veterinary Section of the Indian Science Congress held in January 1931 at Nagpur.

(4) *Spot-plate technique as used for performing the methyl-red test.*—In 1923 a spot plate technique was developed for performing the Voges-Prausker's test reducing the period required for a definite reaction from several hours to a few minutes. By means of a similar technique it has been found possible to carry out the methyl-red test on the glucose broth culture. In short, the technique is to place a 5-mm. loopful of the glucose-broth culture on an opal glass plate and mix a 2-mm. loopful of the methyl-red solution in the drop. The advantage of the spot-plate test consists in the fact that the test can be carried out on the same culture from day to day. Interesting data is being accumulated and will form the subject of a separate communication shortly.

II. *The Standardisation of Anti-Plague Vaccine.*

(*a*) *Immunity tests with a constant test virus.*—Work on the elaboration of a biological method for the standardisation of Haffkine's Plague Prophylactic was continued during the year by Major Sokhey and Dr. La Frenais. As reported before, duplicate determinations by the method in use in the Institute gave variations of 300 per cent. or more. This method consists of giving ½ cc. of the plague prophylactic to be tested to a number (30-60) of Madras rats and one week later 0·003 mg. of a plague spleen is given as the test virus. In such tests, besides the vaccine the more important variables are the test animal, the dose of the test virus, the time lapsing between the giving of the vaccine and the test virus. Each of these variables has been studied separately.

The question of the test virus was taken up first. Counts were made on seven test viruses actually used in routine work. The dose of 0·003 mg. of plague spleen was found to contain plague bacilli varying from 120 to 46,000 organisms. On the assumption that such a great variation in the number of organisms is likely to produce variation in the immunity response of the test animals, an attempt has been made to secure a test virus containing a definite number of organism of a known virulence. By comparatively simple cultural methods such a virus has been successfully prepared. Experiments showed that excessively large numbers of organisms should not be used as a test virus, and it has been found that a test dose of between 40 and 100 organisms of a strain. 10 organisms of which are enough to kill between 70 per cent. and 100 per cent. of the susceptible test animals, is the most suitable. Five immunity determinations on the same sample of vaccine, using this test virus gave immunity percentages of 23, 25, 26, and 26 and 32 respectively. The same vaccine when tested with a test virus 100 times as strong gave immunity percentages of 9, 14, and 27.

The standardisation of the test virus has improved the results, but not sufficiently to enable the test to be used as a standard measurement. The time lapsing between the giving of the vaccine and the giving of the test virus was next lengthened from 7 to 11 days, as at the end of 7 days some of the animals still looked ill. Variations in the amount of vaccine used were then tried. ½cc. of the vaccine appears to be too large a dose. In spite of all these modifications, the duplicate results were still not close enough. Attention was therefore turned to the test animal itself. The test animal used, as described by the original authors, is the Madras house rat. Rats are caught for us in Madras and sent to Bombay. Such an animal is obviously unsuitable for biological experiments. We know neither the age nor the state of nutrition of our test animals. It seemed likely that it would improve matters if a laboratory bred animal could be used, and at present experiments are being carried out with white mice and white rats.

In over 40 tests carried out with white mice between 20 and 30 g. in weight, as the test animals, the duplicate tests have shown a variation of not more than 20 per cent.

Since the albino rat is the more universal laboratory animal, experiments are being conducted to see how it would serve our purpose. The few experiments that have been carried out so far have given excellent duplicate results.

It is believed that Major Sokhey and Dr. La Frenais have successfully devised a test which gives dependable measurements of the immunising value of plague vaccines.

The next procedure was to determine the minimum amount of Haffkine's Plague Prophylactic which would confer complete immunity against plague in the test animals. It is found that 1/16 cc. of a three weeks growth of the prophylactic confers absolute immunity in white mice averaging between 15 g. to 20 g. in weight. By absolute immunity is meant that all the experimental white mice escape death if they are given the test virus 11 days after receiving 1/16 cc. of the plague prophylactic, while all the controls die.

(*b*) *Haffkine's Plague Prophylactic compared with vaccine made from growth on solid medium.*—A considerable amount of work has been reported from this laboratory from time to time showing that Haffkine's Plague Prophylactic is superior to Plague Vaccine made from plague bacillus grown on a solid medium. A critical examination of this assertion was next undertaken.

The first thing in this investigation obviously was to make a vaccine from a growth on a solid medium-agar slopes containing the same weight of organisms as is contained in an equivalent quantity of Haffkine's Plague Prophylactic. As is well known Haffkine's Plague Prophylactic is a 3-6 weeks' growth of plague organisms in broth and during this period of growth an unknown amount of organisms go into solution in the medium. By chemical means (see under Biochemical Unit) it has been possible to determine the total amount of organisms in suspension and in solution in 1/16 cc. of the prophylactic, the dose that confers complete immunity in white mice. The next step was to prepare an agar vaccine containing *the same weight of organisms.* When this was tested, it was found to *confer complete immunity in white mice exactly like Haffkine's Plague Prophylactic.* If tentative conclusions may be formed at this stage before the work is completed, this work suggests that the immunity conferred by plague vaccine is a function of the weight of organisms used in immunising, and that the so-called toxicity is also a function of the same weight. Thus Haffkine's Plague Prophylactic falls into line with vaccines of organisms that produce no extra-cellular toxins.

The practical results of this investigation have already proved of value in the manufacture of Haffkine's plague prophylactic.

During the last 3 years, methods have been developed to ensure (1) absolute purity of the seed ; (2) definite virulence of the plague strain used as the seed—only those strains are used of which 5-10 organisms kill 70 to 100 per cent. of susceptible white mice or rats of a given weight ; (3) chemical studies which were started some time ago by Major Sokhey and his assistants and are reported elsewhere have enabled us to make

different batches of the broth for the manufacture of Haffkine's Plague Prophylactic of uniform composition. The successful standardisation of the virulence and purity of the seed and the composition of the medium, gives us the right to say that *we can turn out Haffkine's Plague Prophylactic of uniform immunising value.*

Of course the whole position will have to be reviewed when the present work is completed. It will then have to be decided whether plague vaccine should not be made from growth on a solid medium in order to reduce the bulk of the dose used.

III. Parasitology and Transmission of Plague.

(*a*) *The role of the non-pectinate rat-fleas in India.*—The study of the flea factor in plague epidemiology was continued until August 1930, when this part of the inquiry was interrupted by the departure of Major Webster on long leave.

A continous transmission experiment with pure bred *Xenopsylla brasiliensis* fleas was kept up successfully from the end of May until the end of August. With a large flea population it is concluded that all-the-year-round transmission can be readily demonstrated in Bombay with the three species of Xenopsylla.

As the result of examining a large number of infected fleas from the *brasiliensis* pit a small number of blocked specimens of this species have been detected. No means has so far been devised for increasing the proportion of blocked individuals. It is not known why only an occasional infected flea becomes blocked.

The mixed flea experiments on strictly comparative lines have continued to show *X. brasiliensis* as a particularly regular transmitter, while *X. astia* is much less often successful than either *cheopis* or *brasiliensis*.

In connection with the continuous transmission experiment with pure bred *X. astia* fleas observations were carried out to determine to what extent starved infected fleas could restart the epizootic. The rats were removed and the fleas were left without a host for certain periods after which fresh test rats were added. As a result the epizootic was successfully restarted after breaks of 3, 4, 5, 6, and 7 days respectively.

Pulex irritans.—This species is found more difficult to deal with in the laboratory for three main reasons: (*a*) Breeding experiments with white mice, *Rattus rattus*, *R. norvegicus*, Gunomys sp., rabbits, guineapigs, musk rats, puppies and cats gave poor results. In no case was a satisfactory supply of laboratory bred fleas obtained. The chief hindrance is the fouling of the litter and the development of moulds when the larger animals are used. With the mice, on which the Xenopsylla fleas have been raised so easily, this fouling does not occur. (*b*) Only a very few parent fleas have been recovered in these breeding experiments so that no controlled transmission experiments have been attempted. The rapid disappearance of human fleas when restricted to rodent hosts was noted by the Plague Commission. (*c*) The greater

activity of the species and the greater attractiveness of man for *Pulex irritans* combine to make it inadvisable to handle individual human fleas by the methods which are so simple in the case of plague infected Xenopsylla fleas.

As regards future work it is considered that attention should be largely focussed on individual fleas which are proved capable of transmitting the infection. In the very large majority of infected fleas the plague bacillus has apparently entered a blind alley. *Pulex irritans* might be studied profitably in the field. As a first step the proportion of plague infected human fleas caught in plague houses might be compared with similar data for the Xenopsylla fleas. A reliable technique for cultural test of fleas for plague infection is available. If plague infected human fleas are actually found the subject may be pursued further.

(*b*) *The efficacy of various flea repellents and pulicides.*—A number of substances reputed to exert an adverse effect on fleas were tested under experimental conditions to determine (1) their action as flea-repellents and (2) their lethal action on fleas. In these experiments marked differences were observed in the power of the various preparations to prevent flea-infestation of live rats exposed in flea-infested pits for varying periods of time.

As regards the lethal action on fleas of the different substances used, little difference was observed when fleas (*X. cheopis*) were exposed to the vapour only, indeed, judging by controls exposed to water vapour only, it can hardly be said that any of the vapours exerted a definite lethal effect. When, however, the fleas were allowed to come in direct contact with the preparation most of the pulicides used were completely effective after 16 hours, the shortest period of observation, while one proprietory preparation was almost ineffective.

(*c*) At the request of the Port Health Officer, a series of observations was carried out by Dr. Chitre to determine the different character and appearance of fæces passed by *R. rattus* fed exclusively on certain food grains. Ten different grains were employed for this purpose.

Pierce writing in the "Medical Officer" of 17th May 1930, drew attention to the very different types of rat excreta found in the holds of ships when the food available consisted predominantly of certain diet and emphasized the value of this fact in connection with the deratisation of ships. Our experimental findings largely confirmed Pierce's observations. Preserved specimens of the various types of fæces were supplied to the Port Health Officer.

(*d*) *Detection of plague infection in decomposed rats.*—In collaboration with Dr. Gore a series of observations was carried out by Dr. Chitre to determine up to what period after post-mortem putrefaction had set in it was possible to detect plague infection in the bodies of dead rats. The rats were artificially infected with plague and after death the bodies were allowed to decompose and were examined after varying periods for naked eye and microscopic signs of plague and by animal inoculation and Gore's cultural method described last year in this Report.

The temperature conditions at the time of this investigation were as follows: Dry bulb—Max. 95·4°, min. 83·0°, mean 89·2°. Wet bulb—Max. 76·0°, min. 72·6°, mean 74·3°. Under these conditions it was not possible to detect the presence of plague infection by any of the above methods—two days after death of the animal. It must be concluded therefore that a negative finding in such circumstances does not exclude the possibility of the animal having died of plague.

IV. Anti-Plague Serum.

The possibility of preparing a potent antiplague serum has been the subject of study of Dr. Naidu and his assistants since 1927. This work was continued throughout the year. From their experimental results, reported previously, they concluded that it is possible to prepare from animals, such as sheep and calves, which are naturally susceptible to Pasteurellosis, a potent antiplague serum by repeated intravenous injections of a virulent live culture of *B. pestis* isolated from local cases of human plague.

During the year, nine sheep, four bulls and four buffaloes were immunised to obtain a large supply of serum in order to test its curative value in the plague stricken man. The serum was first tested in experimentally infected rabbits and the results showed that about 80 per cent. of the infected animals recover from the disease under treatment. A trial was then carried out at Lingampalli Plague Hospital, Hyderabad (Deccan), by the kind permission of Col. Norman Walker, I.M.S. and the staff of the Hospital. 76 cases which came under observation were diagnosed by cultural methods and were divided into three classes, namely, (A) cases in which there was a heavy septicæmia of *B. pestis* with or without buboes, (B) cases in which there was early or light septicæmia or infected bubo without septicæmia, and (C) cases clinically plague but the bacteriological confirmation was not afforded. The cases submitted to treatment with serum were 43 of which 15 died and the controls, which were treated on identical lines except that they received no serum, were 33 of which 23 died. As regards class (A) it has always been held previously that septicæmic cases were always fatal; all the 17 controls died under this class: but out of the 15 cases treated with serum 4 recovered. Clinically the recovery of some cases which had over 100 plague bacilli in 1 cc. of blood is remarkable.

Class (B) provided the most interesting information, although the figures were unfortunately very small. It includes cases which had a light septicæmia or early septicæmia. It also includes those cases in which *B. pestis* was recovered by bubo culture but in which the blood was found sterile. This class includes 19 cases treated with serum with 4 deaths and 8 cases without serum with 4 deaths.

Class (C)—Clinically Plague.—There were nine cases with no deaths with the serum treatment, and eight cases with two deaths among the controls.

A striking bacteriological observation was made that in many cases under the serum treatment septicæmia was remarkably reduced, and in

several cases abolished within 24 to 48 hours of the administration of the serum. This suggests that this serum may be possessed also of bactericidal properties, as previous experiments on animals have already demonstrated the existence therein of anti-toxic properties. From the clinical point of view, the improvement of some cases under serum treatment was remarkable : the fever going down, eyes becoming clear, delirium disappearing and heart improving in tone within few hours of the administration of the serum.

Comparative Test on some Antiplague Sera.—At the suggestion of Dr. Petrie of the Lister Institute, London, comparative experiments on lines planned out by him were undertaken on Madras rats with two antiplague sera from the Lister Institute along with the Pasteur Institute serum and the sera prepared by us locally. These experiments involving the use of 1,330 rats were carried out in order to test the three distinct properties of these sera, namely, the protective, the anti-toxic and the curative. The results showed that even these concentrated sera were not as potent as the unconcentrated sera locally prepared.

Prophylactic Value of Anti-Plague Bilivaccine.—At the request of Messrs. G. Loucatos & Co., experiments were carried out to study the protective value of " Bilivaccine Anti-Plague Vaccine " manufactured by " La Biotherapie, 131, Rue Cambronne, Paris," along with Haffkine's Plague Prophylactic, for comparison, in rabbits, animals which yield more consistent results than the Madras rats. The doses of the vaccine employed were those recommended for man. In all 110 rabbits were used for the purpose. After an interval of 7 to 14 days after immunization, they were infected with our test dose of plague bacilli. The results showed that among rabbits protected with Bilivaccine there was a mortality of 86·3 per cent. ; among those treated with Haffkine's Plague Prophylactic there was not a single death ; while among the controls the mortality was 73·3 per cent.

" *Germanin—Bayer* 205 " (*For Human Use*).—Dr. Vincent of Maymyo stated that he had obtained very good results from the administration of " Bayer 205 " in cases of plague in Burma. Dr. Dyce Sharpe also reported successful cures with this drug in plague cases. Experiments were, therefore, undertaken to test the toxicity and curative value of the drug in rabbits. The results showed that " Germanin " had no germicidal value *in vitro* on a culture of *B. pestis* even in a dilution of 1 in 20 when exposed for 24 hours. It was found that when the drug was administered in a single dose of 0·6 gramme intravenously or when it was administered in repeated doses of 0·1 gramme at intervals of 24 hours for six days, it had no toxic effect, but 0·7 gramme either administered in a single dose or in cumulative repeated doses of 0·1 gramme each at intervals of 24 hours, was fatal.

To study the results of the curative value of this drug 25 rabbits were infected subcutaneously with plague. They were treated with varying amounts of " Germanin". In one series, the first dose was injected immediately after infection. Some of the infected animals received a single dose while in others the doses were repeated at intervals of 24 hours.

Out of 10 rabbits treated with a single dose varying from 0·1 to 0·45 gramme intravenously, none survived by the eighth day after infection. Of the 10 rabbits treated with repeated doses in total amounts varying from 0·3 to 0·5 gramme 9 died by the twelfth day of infection, while the mortality among the 10 control rabbits was 80 per cent. during the same period. In another series, treatment was commenced after 24 hours of infection and the infected animals received three doses of 0·1 gramme of the drug at intervals of 24 hours. All the five rabbits so treated died by the eighth day after infection. For purposes of comparison ten other infected rabbits were treated at the same time with our local antiplague serum. All the serum-treated animals survived, while four out of the five control rabbits died within nine days after infection.

V. Chemotherapy of Plague.

The work done on this problem, and reported in last year's Annual Report has been carried forward a further stage.

During the year under review the " safe dose " of each of the twelve halogenomercuriphenols was determined for pure bred English rabbits. The results show that the toxicity of the compounds does not depend on the amount of mercury present in the molecule.

Seven out of the twelve halogenomercuriphenols were given a trial in the treatment of plague-infected rabbits. The number of animals treated was 42 as against 17 controls.

All the controls exhibited the same infection picture. Septicaemia invariably set in some time after the inoculation of the bacilli; the time elapsing between the inoculation and the appearance of septicaemia depending upon the number of bacilli injected and their virulence, and the time between the onset of septicaemia and death averaging 64 hours.

The results are encouraging seeing that: (*a*) 1 animal was cured; (*b*) septicaemia was completely inhibited in 10 cases; (*c*) septicaemia was delayed in 20 cases, the delay varying from 12 to 72 hours; (*d*) death was delayed in 26 cases, the lease of life varying from 2 to 100 hours.

Inquiry on Maternal Morbidity and Mortality in Childbirth.

Pernicious Anaemia of Pregnancy.—The work of this Inquiry has been divided into (*a*) further studies in the clinical pathology, (*b*) trial of treatment by dietetic means, (*c*) a further dietetic survey and (*d*) animal experiments.

(*a*) and (*b*). The fact that post-mortems are unobtainable has handicapped the work, but from the evidence available there is no indication of a specific infection as in the experimental anaemia produced in rats by faulty feeding. The possibility of the same two etiological factors functioning in the human as in the animal cases, i.e. a dietetic and an infective factor cannot be ruled out, and the occurrence of a macrocytic

anaemia as distinct from the usual secondary anaemia, in such conditions as malaria, syphillis and hookworm disease lends support to this view. That a dietetic deficiency is involved is indicated by the greater frequency of this anaemia in pregnancy and spontaneous recovery post delivery, the nature of the diets used in countries where the disease occurs and the curative action of liver and in certain cases of other tissue extracts. The reticulocyte count has been used as a criterion of the effectiveness of any drug or extract or of spontaneous cure.

(*c*) The dietetic survey was continued and our previous findings concerning the diets of women of the millworker class and the mothers of premature infants were confirmed. The diets of the latter class were even more deficient than in the previous survey.

(*d*) The monkey experiments are not yet completed and the results are inconclusive. The experimental diet (the same as produced anaemia in rats) is based on one in common use in Bombay. Marked changes are produced in the haematopoietic system but in the earlier work the animals died before their blood count had become markedly lowered. In certain animals on a modified diet a macrocytic anaemia has been produced but these experiments are still in progress and the significance of the findings is not yet clear.

Tuberculosis Inquiry.

This Inquiry was continued by Dr. Soparkar and his assistants at the Haffkine Institute throughout the year under review.

The nature of organisms responsible for non-pulmonary forms of human tuberculosis has been under investigation for some time and the results hitherto obtained have shown that the bovine bacillus plays a negligible part in the causation of these forms of tuberculosis at least in the Western Presidency. Further work was done upon cases from other parts of India and material was collected from the Punjab where animal tuberculosis was recently found to be more prevalent. Nineteen cases were collected from the hospitals and nine strains were isolated and studied and one of these was found to be of the bovine type. The number of cases examined is not large but it indicates that the chances of infection with the bovine bacillus are comparatively greater in this part of India.

Types of Tubercle Bacilli isolated from Indigenous Cattle.

The finding of a considerably large proportion (from 20 to 30 per cent.) of Indian cattle affected with tuberculosis in some parts of the Punjab has already been reported.

Previous studies of over 60 strains isolated from these and other animals have shown that they all belonged to the bovine type except in one instance of a conservancy bull from Madras from which the organisms isolated were found to be a mixture of bovine and avian strains. In the course of the present study of animals from the Punjab six strains were isolated from lesions in the thoracic glands and two of these have

proved to be of the human type. This is probably the first instance to be recorded of isolation of a human type of bacillus from cases of *natural* infection in cattle. Park and Krumweide observe that " Considering.... the fact that in no instance has a culture been isolated directly from cattle showing the characteristics of the human type the question of possible infection of cattle from man under natural condition is practically settled. The recent findings would indicate that such infection of cattle from man may take place and the habits of the people in the Punjab would support the view.

Prevalence of Tuberculosis among Animals other than Domestic Cattle.

Early during the year, the Superintendent of the Zoological Gardens, Bombay, sent for examination a carcase of a sambar (*cervus affinis*) that had died in the gardens. Autopsy showed extensive tuberculosis of the lungs and the pericardium and smears from the secretion in the trachea contained numerous tubercle bacille. A strain was isolated from the lesions and it proved to be of a virulent bovine type. In view of this findings, at our suggestion the Superintendent allowed the examination of other sambars in the same compound for infection by the tuberculin test and out of nine sambars tested seven reacted. Three of these were subsequently destroyed and autopsy revealed a few tuberculous lesions in one and only suspicious lesions in the other two, but when material from these animals was inoculated into guinea pigs all of them developed severe tuberculosis. Strains were isolated from them and were found to be of the bovine type of high virulence showing that the animals did not acquire the infection from the visitors to the gardens but probably from other animals infected with bovine bacilli. It may be noted here that fifteen years ago, we investigated an outbreak of tuberculosis that occurred among several animals in the same gardens and found that the infection then was also of the bovine type and the source of infection was traced to two llamas imported from Germany. It would be interesting to investigate whether the present small outbreak was due to the old infection still lingering in the gardens or to any new animals recently introduced.

Filtrability of the Tubercle Bacillus.

The existence of a filter passing form of the tubercle bacillus is claimed to have experimentally proved by some French workers but others have obtained negative results. Investigation on this problem has been in progress for some time. Results of a large number of carefully controlled experiments made with tuberculous tissues, cultures and pathological material, have shown positive findings in only two out of thirty-two experiments and acid fast bacilli were detected in the tissues of guineapigs inoculated with the filtrate. In view of the findings of other workers of acid fast bacilli in a large proportion of apparently healthy guineapigs this finding could not be taken as conclusive and it was necessary to establish the identity of any acid fast bacilli detected with *Mycobacterium tuberculosis.*

A further series of experiments was, therefore, undertaken in which a number of passages were made on a series of guineapigs on somewhat different lines from those adopted in the previous experiments.

In this series out of 10 experiments acid fast bacilli were found in several of the passage guineapigs in 8 experiments. These were detected for the first time in two experiments in the first passage, in one experiment in the second passage, in three experiments in the third passage, in one experiment in the fourth passage and in one experiment in the sixth passage. Attempts at isolation of cultures of these acid fast bacilli were made and in five cases strains also were isolated. The experiments are in progress.

Solid Media for the Cultivation of the Tubercle Bacillus.

As local batches of potatoes—a medium which is largely used for the cultivation of the tubercle bacillus—failed on several occasions to give a satisfactory growth, attempts were made to find a suitable substitute and the properties of certain indigenous vegetables and tubers were investigated. Out of six vegetables and tubers tried, the plantain (*Musa sapientum, Linn.*) was found to give a satisfactory growth. All varieties of plantains, however, did not yield good results and only one variety proved satisfactory. Another substitute which proved to be nearly as good was "Arvi" (*Colocasia antiquorum, Schott*). Further experiments are being undertaken.

Spontaneous Tuberculosis in Laboratory Animals.

How far tuberculosis occurs spontaneously in laboratory animals is a subject of practical importance. The trend of opinion is that its occurrence is very rare. Experiments were designed to study this question and healthy rabbits were kept along with infected ones (1) in the same cage and (2) in adjoining cages for prolonged periods. The results showed that five out of 10 rabbits kept in the same cage along with infected animals developed the disease after exposure of 49, 62, 73, 136 and 182 days respectively while the remaining ones were free from infection although their exposure had lasted for 38, 45, 75, 93 and 105 days respectively. Of the rabbits kept in adjoining cages to those of the infected ones one developed severe tuberculosis after an exposure of 48 days while another failed to show any signs of the disease even after an exposure of 75 days. Further work on these lines is in progress.

Cultural Studies of Tubercle Bacilli.

A large number of strains that had been isolated from various sources were studied by "cultural tests". One hundred and three strains of tubercle bacilli of the human and the bovine types were studied on the following media, viz. plain serum agar, glycerin serum agar, glycerin agar, glycerin egg, glycerin potato and glycerin broth. An approximately equal amount of seed material was planted on each comparative medium and the observation was continued for six weeks, the rate, amount and the character of the growth being noted.

Epidemiology of Tuberculosis.

A preliminary survey of the prevalence of tuberculous infection amongst the population was made in the Punjab and examination was carried out in certain schools in the urban as well as rural areas and also in the district jail. The method employed was by cutaneous tuberculin test. Over 700 individuals both adults and children were tested.

Systematic work in this direction was commenced in November, 1930, and through the courtesy of the Inspector General of Prisons, Bombay, examination was carried out in many of the jails of the Presidency including Sind, the total number of tests carried out being over 5,600. Inmates of the hospital for mental diseases, Poona, numbering over 700 were also tested for the presence of infection through the courtesy of the Superintendent, Major E. C. Smith, I.M.S.

In Sind the Chief Officer of the Sukkur Municipality and the Health Officer rendered considerable assistance, and 632 boys of the local Municipal primary schools were tested.

Tests were also carried out on over 7,500 operatives of the various textile mills in Ahmedabad through the courtesy of the Ahmedabad Mill-owners' Association and the assistance of the Secretary, Mr. Goverdhan I. Patel. Through the kindness of the Health Officer and the Chief Officer, Ahmedabad Municipality, 986 municipal scavengers in the city were tested. The Secretary of the Ahmedabad Labour Union evinced considerable interest in the work and through his assistance it was possible to carry out the test on 754 boys and staff of the labour union school.

A paper was read before the meeting of the Indian Science Congress held at Nagpur in January, 1931, on "The Incidence of Tuberculosis among Cattle in India".

LIST OF PAPERS PUBLISHED DURING THE YEAR.

1. Caius, J. F. and Bharucha, K. H.—Earth-eating and Salt-licking in India. Analyses IV–VII; VIII–XIII. Journ. Bomb. Nat. Hist. Soc.; XXXIV, 1, 1st March 1930; XXXIV, 2, 15th July 1930.
2. Mhaskar, K. S. and Caius, J. F.—A study of Indian Medicinal Plants II. *Gymnema sylvestre* Br. Indian Medical Research Memoirs. Memoir No. 16; March 1930.
3. Mhaskar, K. S. and Caius, J. F.—Indian Plant Remedies used in Snake-bite (Sanskrit). December 1930.
4. Caius, J. F., Mhaskar K. S. and Isaacs, M.—A comparative Study of the dried Barks of the commoner Indian Species of Genus *Terminalia* Linn. Indian Medical Research Memoirs. Memoir No. 16; March 1930.
5. Caius, J. F.—A caza de serpientes. Iberica; XXXIII, 823; 12th April 1930.

6. CAIUS, J. F.—The Toxicity of the Venom of Indian Scorpions. II. *Buthus alticola* Pocock. Journ. Bomb. Nat. Hist. Soc.; XXXIV, 3, 15th November 1930.

7. CAIUS, J. F. and MHASKAR, K. S.—Therapeutic Notes on some Plants used medicinally in India. (in English) 8th Congress of F.E.A.T. M., Bangkok, December 1930. (in Sanskrit) December 1930.

8. WEBSTER, W. J. and CHITRE, G. D.—Observations on Rat-fleas and the Transmission of Plague. Part II. Rat-flea Survey of Bombay City. Ind. Journ. Med. Res. XVIII. 1, p. 337.

9. WEBSTER, W. J.—Observations on Rat-fleas and the Transmission of Plague. Part III. On the Bionomics of the Indian Xenopsylla Fleas. Ind. Journ. Med. Res. XVIII. 2, p. 391.

10. WEBSTER, W. J. and CHITRE, G. D.—Observations on Rat-fleas and the Transmission of Plague. Part IV. Experimental Plague Transmission. Ind. Journ. Med. Res. XVIII. 2, p. 407.

11. WILLS, LUCY and TALPADE, SAKUNTALA K.—Studies in Pernicious Anaemia of Pregnancy. Part II. A Survey of Dietetic and Hygienic Conditions of Women in Bombay. Ind. Journ. Med. Res., XVIII. 1, p. 283.

12. BALFOUR, M. I. and TALPADE, S. K.—The Maternity Conditions of Women Mill-workers in India. Ind. Med. Gaz. LXV. 5, p. 241.

13. THOMSON, CHRISTINE, J.—Still-Birth and Neo-Natal Death in India. Monograph published by the Lady Irwin Research Fund.

14. BALFOUR, M. I.—Early infant mortality in India with special reference to premature birth. Ind. Med. Gaz. LXV, 11, p. 630.

L. A. P. ANDERSON,
Major, I.M.S.,
Acting Director, Haffkine Institute.

Parel, Bombay,
12th October 1931.

APPENDICES.

TABLE I.

A general statement regarding patients treated at the Institute and its Centres from 1922 to 1930.

Year		Europeans				Asiatics				Europeans and Asiatics combined			
		Total treated	Total deaths	Total death rate per cent.	Advice cases	Total treated	Total deaths	Total death rate per cent.	Advice cases	Total treated	Total deaths	Total death rate per cent.	Advice cases.
1922	Institute	64	..	..	..	385	4	1·04	175	449	4	0·89	175
	Centres												
	Combined												
1923	Institute	115	..	..	59	730	10	1·37	359	845	10	1·18	418
	Centres												
	Combined												
1924	Institute	62	1	1·61	41	525	9	1·71	372	587	10	1·70	413
	Centres												
	Combined												
1925	Institute	42	..	..	27	583	6	1·02	219	625	6	0·96	246
	Centres												
	Combined												
1926	Institute	60	..	..	51	588	5	0·87	440	648	5	0·76	491
	Centres												
	Combined												
1927	Institute	51	..	..	37	678	6	0·88	468	729	6	0·82	505
	Centres												
	Combined												
1928	Institute	39	..	..	40	679	6	0·88	418	718	6	0·83	458
	Centres												
	Combined												
1929	Institute	35	..	..	43	650	5	0·77	522	685	5	0·73	565
	Centres												
	Combined												
1930	Institute	26	..	..	34	710	..	*Nil.*	401	736	..	*Nil.*	435
	Centres	314	1	0·31	10	4,692	50	1·07	92	5,006	51	1·01	102
	Combined	340	1	0·29	44	5,402	50	0·93	493	5,742	51	0·89	537

TABLE II.

A general classification of patients attending the Institute and its Centres during 1930.

Institute.

	Europeans					Asiatics				
	Class of case treated					Class of case treated				
	I	II	III	IV	Total	I	II	III	IV	Total
Number fully treated	7	8	9	2	26	28	227	356	99	710
Percentage to total	26·9	30·7	34·6	7·6	..	3·9	31·9	50·1	13·9	
Total deaths										
Total death rate per cent. ..										
Percentage of health returns					100					88·3
Number not fully treated (presumably at risk)					1					133
Advice Cases (not at risk)					34					401
Cases excluded from the statistical tables for other reasons					..					..
Total					35					534
Grand Total					61					1,244

TABLE II-a.

A general classification of patients attending the Institute and its Centres during 1930.

Centres.

	Europeans					Asiatics				
	Class of case treated					Class of case treated				
	I	II	III	IV	Total	I	II	III	IV	Total
Number fully treated	150	72	76	16	314	136	1,618	2,567	371	4,692
Percentage to total	47·78	22·93	24·20	5·09	..	2·8	34·5	54·8	7·9	..
Total deaths	..	..	..	1	1	..	11	17	22	50
Total death rate per cent. ..	..	..	..	6·25	0·31	..	0·68	0·66	5·9	1·06
Percentage of health returns					77·3					70·9
Number not fully treated (presumably at risk)					13					517
Advice Cases (not at risk)					10					92
Cases excluded from the statistical tables for other reasons										..
Total					23					609
Grand Total					337					5,301

TABLE III.

Classification of patients according to position of wounds, interposition of clothing and probability of rabies in the biting animal.

Numerators—Deaths. Institute. *Denominators*—Cases.

A—Animal proved rabid.
B—Animal certified rabid.
C—Animal probably rabid according to history.
D—History of animal unknown.
E—Animal probably not rabid according to history.

	Europeans							Asiatics							Total	Death rate per cent.
	A	B	C	D	E	Total	Death rate per cent.	A	B	C	D	E	Total	Death rate per cent.		
Bitten on Face	1	..	..	..	..	1	*Nil.*	1	2	7	7	..	17	*Nil.*	18	*Nil.*
Bitten on Trunk and Extremities (bare skin) ..	3	..	2	6	..	11	,,	22	23	202	245	..	492	,,	503	,,
Bitten on Trunk and Extremities (through clothing) ..	2	..	..	5	..	7	,,	4	3	58	107	..	172	,,	179	,,
"Licks" on any part of the body	6	1	..	..	..	7	,,	1	4	11	13	..	29	,,	36	,,
Total ..	12	1	2	11	..	26	*Nil.*	28	32	278	372	..	710	*Nil.*	736	*Nil.*
Percentage to total ..	42·3	3·8	7·6	42·3	..	..	..	3·9	4·5	39·1	52·3	..	..	..	..	..
Percentage death rate ..			*Nil.*							*Nil.*						

TABLE III-a.

Classification of patients according to position of wounds, interposition of clothing and probability of rabies in the biting animal.

Numerators—Deaths. *Denominators*—Cases.

Centres.

A—Animal proved rabid.
B—Animal certified rabid.
C—Animal probably rabid according to history.
D—History of animal unknown.
E—Animal probably not rabid according to history.

	Europeans							Asiatics							Total	Death rate per cent.
	A	B	C	D	E	Total	Death rate per cent.	A	B	C	D	E	Total	Death rate per cent.		
Bitten on Face	1/3	1	4	2	..	1/10	10·0	1/1	1/21	16/174	1/52	..	19/248	7·6	20/258	7·7
Bitten on Trunk and Extremities (bare skin) ..	4	21	30	39	..	94	..	1/38	1/105	22/1,857	2/915	..	26/2,915	0·88	26/3,009	0·86
Bitten on Trunk and Extremities (through clothing) ..	18	7	14	17	..	56	..	14	1/98	3/948	1/333	..	5/1,395	0·35	5/1,449	0·34
"Licks" on any part of the body	42	75	35	2	..	154	..	14	71	43	8	..	136	..	290	..
Total ..	1/67	104	83	60	..	1/314	..	2/67	3/295	41/3,022	4/1,308	..	50/4,692	..	51 5,006	..
Percentage to total ..	21·3	33·1	26·5	19·1	..	..	..	1·4	6·2	64·6	27·8	..	..	..	..	..
Percentage death rate ..	1·4	..	..	..	..	0·31	..	2·9	1·0	1·3	0·35	..	1·8	..	1·01	..

TABLE IV.

Age and sex distribution of patients treated at the Institute and its centres.

Numerators—Deaths. *Denominators*—Cases.

Institute.

Age in years	Europeans				Asiatics				Europeans and Asiatics combined	
	Males	Females	Total	Death rate per cent.	Males	Females	Total	Death rate per cent.	Total	Death rate per cent.
0—4	..	1	1	*Nil.*	13	5	18	*Nil.*	19	*Nil.*
5—9	3	..	3	,,	65	29	94	,,	97	,,
10—14	1	2	3	,,	85	18	103	,,	106	,,
15—19	..	1	1	,,	57	13	70	,,	71	,,
20—29	6	3	9	,,	126	22	148	,,	157	,,
30—39	2	3	5	,,	105	17	122	,,	127	,,
40—49	1	..	1	,,	66	22	88	,,	89	,,
50—59	1	..	1	,,	32	20	52	,,	53	,,
60—69	1	1	2	,,	9	4	13	,,	15	,,
70 and over	..	..	..		..	2	2	,,	2	,,
Total ..	15	11	26	*Nil.*	558	152	710	,,	736	*Nil.*

TABLE IV-a.

Age and sex distribution of patients treated at the Institute and its Centres—contd.

Numerators—Deaths. Centres. *Denominators*—Cases.

Age in years	Europeans				Asiatics				Europeans and Asiatics combined	
	Males	Females	Total	Death rate per cent.	Males	Females	Total	Death rate per cent.	Total	Death rate per cent.
0—4	15	13	28	..	7/166	56	7/222	3·1	7/250	2·8
5—9	1/18	12	1/30	3·3	6/582	3/192	9/774	1·1	10/804	1·2
10—14	11	16	27	..	7/483	108	7/591	1·1	7/618	1·1
15—19	4	6	10	..	4/344	2/58	6/402	1·4	6/412	1·4
20—29	76	18	94	..	2/1,050	1/155	3/1,205	0·24	3/1,299	0·23
30—39	44	25	69	..	1/655	128	1/783	0·12	1/852	0·11
40—49	25	19	44	..	5/289	2/105	7/394	1·7	7/438	1·5
50—59	5	5	10	..	3/147	1/69	4/216	1·8	4/226	1·7
60—69	1	1	2	..	3/59	2/32	5/91	5·4	5/93	5·3
70 and over	..	..	..	..	1/8	6	1/14	7·1	1/14	7·1
Total ..	1/199	115	1/314	0·31	39/3,783	11/909	50/4,692	1·07	51/5,006	1·01

TABLE V.

Classification according to number and position of wounds.

Numerators—Deaths. *Denominators*—Cases.

Europeans.
Institute.

Position	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Leg ..	..	2	6	3	1	1	..	..	..	..	..	..	..	..	..	..	13	*Nil.*
Trunk ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	„
Arm ..	7	2	2	..	..	1	..	..	..	..	..	..	..	..	..	..	12	„
Multiple ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	„
Face ..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1	„
Multiple face ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	„
Total ..	7	4	9	3	1	2	..	..	..	..	..	..	..	..	..	..	26	„
Percentage death rate.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	....	. ..

Separate table for Europeans and Asiatics; also for Institute and Centres :—

(V) Europeans—Institute.
(V-a) „ —Centres.
(V-b) Asiatics —Institute.
(V-c) „ —Centres.

TABLE V-a.

Classification according to number and position of wounds.

Numerators—Deaths. *Denominators*—Cases.

Europeans.
Centres.

Position	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Leg ..	..	17	18	9	6	3	..	..	1	..	..	..	..	2	..	..	56	..
Trunk ..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..	2	..
Arm ..	154	31	24	10	5	3	3	..	2	1	1	..	..	..	..	..	234	..
Multiple ..	..	..	4	1	1	2	2	1	..	..	1	..	..	..	..	..	12	..
Face ..	..	6	2	1/2	..	..	..	..	..	..	..	..	..	..	..	..	1/10	10·0
Multiple face ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total ..	154	55	48	1/22	12	8	6	1	3	1	2	..	..	2	..	..	1/314	0·31
Percentage death rate.	..	..	..	4·5	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE V-b.

Classification according to number and position of wounds.

Numerators—Deaths. *Denominators*—Cases.

Asiatics.
Institute.

Position	Number of wounds																		Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
Leg	..	128	150	91	80	37	18	5	..	1	1	..	..	..	..	2	..	..	513	*Nil.*
Trunk	..	1	2	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	5	„
Arm	29	24	40	26	21	8	4	2	3	..	..	2	..	..	..	1	..	..	160	„
Multiple ..	..	..	..	2	4	1	1	2	..	1	2	..	1	..	..	..	1	..	15	„
Face ..	..	5	3	..	2	1	..	..	..	..	..	..	..	..	..	..	..	1	12	„
Multiple face ..	..	..	..	1	..	..	..	..	2	..	1	..	..	..	..	1	..	..	5	„
Total ..	29	158	195	121	107	47	24	9	5	2	4	2	1	..	..	4	1	1	710	„
Percentage death rate .	*Nil.*																			

Separate table for Europeans and Asiatics; also for Institute and Centres :—

(V) Europeans —Institute.
(V-a) „ —Centres.
(V-b) Asiatics —Institute.
(V-c) „ —Centres.

TABLE V-c.

Classification according to number and position of wounds.

Numerators—Deaths. *Denominators*—Cases.

Asiatics.

Centres.

Position	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and over		
Leg ..	..	2/467	2/901	5/610	6/504	158	117	37	45	16	13	2	4	1	2	1	15/2878	0·52
Trunk ..	..	37	48	47	36	17	10	3	3	1	..	..	..	1	..	..	203	..
Arm ..	136	3/197	1/289	3/204	2/141	1/75	1/52	1/24	20	8	9	3	2	..	1	3	12/1164	1·03
Multiple ..	..	1	2/21	18	36	35	22	22	12	5	1/9	1/3	1	2	1	8	4/199	2·01
Face ..	..	3/32	43	29	4/29	2/9	1/10	1/5	1/6	1	..	1/1	..	..	..	..	13/165	7·8
Multiple face ..	..	1	4	9	1/19	1/10	7	1/4	1/10	2/5	4	1	1	2	1	5	6/83	7·2
Total ..	136	8/735	5/1306	8/917	13/765	4/304	2/218	3/95	2/96	2/36	1/35	2/10	11	6	5	17	50/4692	1·07
Percentage death rate. ..	..	1·09	0·38	0·87	1·8	1·3	0·91	3·1	2·1	6·1	2·8	20·0	..	..	..	..	..	..

TABLE VI.

Classification according to number and depth of wounds and interposition of clothing.

Numerators—Deaths. Europeans. *Denominators*—Cases.

Institute.

Deep Bare	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and over		
+ +	..	1	2	2	1	2	..	..	..	..	..	..	..	..	..	..	8	*Nil.*
+ −	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	2	,,
− +	7	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	11	,,
− −	..	1	4	..	..	..	..	..	..	..	..	..	..	..	..	..	5	,,
Total ..	7	4	9	3	1	2	..	..	..	..	..	..	..	..	..	..	26	*Nil.*
Percentage death rate.								*Nil.*										

TABLE VI-a.

Classification according to number and depth of wounds and interposition of clothing.

Numerators—Deaths. Europeans. *Denominators*—Cases.

Centres.

Deep Bare	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and over		
+ +	..	20	19	1/6	6	2	..	..	1	1	1	..	..	1	..	..	1/57	1·7
+ −	..	4	8	3	2	1	2	1	1	..	1	..	..	1	..	..	24	..
− +	154	25	19	9	3	4	3	..	..	..	..	..	..	..	..	..	217	..
− −	..	6	2	4	1	1	1	..	1	..	..	..	..	..	..	..	16	..
Total ..	154	55	48	1/22	12	8	6	1	3	1	2	..	..	2	..	..	1/314	0·31
Percentage death rate.	..	..	..	4·5	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE VI-b.

Classification according to number and depth of wounds and interposition of clothing.

Numerators—Deaths. Asiatics. *Denominators*—Cases.

Institute.

Deep Bare	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and over		
+ +	..	85	102	66	66	24	13	7	3	2	3	2	1	2	1	1	368	*Nil.*
+ −	..	13	16	21	7	10	6	1	2	..	1	..	..	2	..	..	79	„
− +	29	39	48	23	17	8	1	..	..	..	..	..	..	..	..	..	165	„
− −	..	21	29	21	17	5	4	1	..	..	..	..	..	..	..	..	98	„
Total ..	29	158	195	121	107	47	24	9	5	2	4	2	1	4	1	1	710	*Nil.*
Percentage death rate.								*Nil.*										

TABLE VI-c.

Classification according to number and depth of wounds and interposition of clothing.

Numerators—Deaths. Asiatics. *Denominators*—Cases.

Centres.

Deep Bare	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and over		
+ +	..	3/230	1/481	2/317	9/328	4/141	2/109	2/53	2/52	1/26	24	1/8	4	3	4	11	30/1,747	1·7
+ −	..	72	1/194	1/130	145	48	37	17	24	6	1/7	1	7	1	1	6	3/696	0·43
− +	136	3/271	475	5/312	4/201	62	43	1/13	15	1/2	2	1/1	..	2	..	..	15/1,535	0·97
− −	..	2/156	206	158	91	53	29	12	5	2	2	..	..	..	..	..	2/714	0·28
Total	136	8/735	5/1,306	8/917	13/765	4/304	2/218	3/95	2/96	2/36	1/35	2/10	11	6	5	17	50/4,692	1·07
Percentage death rate.	..	1·0	0·38	0·87	1·8	1·3	0·91	3·1	2·1	6·1	2·8	20·0	..	..	..	..		

TABLE VII.

Classification according to number of wounds and lateness of arrival.

Numerators—Deaths. Europeans. *Denominators*—Cases.

Institute.

Days late	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and over		
0	..	..	1	1	..	1	..	..	..	..	..	..	..	..	..	..	3	*Nil.*
1	..	2	3	..	..	1	..	..	..	..	..	..	..	..	..	..	8	„
2	..	1	2	1	1	..	..	..	..	..	..	..	..	..	..	..	5	„
3	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	„
4	..	1	2	1	..	..	..	..	..	..	..	..	..	..	..	..	5	„
5	..	2	..	1	..	..	..	..	..	..	..	..	..	..	..	..	3	„
6	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	„
7	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
8 to 14	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
15 to 21	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
22 to 28	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
29 to 35	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
36 to 42	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
43 to 49	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
50 and over.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Total	..	7	4	9	3	1	2	..	..	..	..	..	..	..	..	..	26	*Nil.*
Percentage death rate.										*Nil.*								

TABLE VII-a.

Classification according to number of wounds and lateness of arrival.

Numerators—Deaths. Europeans. *Denominators*—Cases.

Centres.

Days late	Number of wounds															Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 and over		
0 ..	16	7	3	1/5	3	1	..	1	1	1	..	..	..	1	..	..	1/39	2·5
1 ..	5	8	10	3	3	2	1	..	..	..	..	..	..	..	..	..	32	..
2 ..	19	11	12	7	3	1	4	..	..	..	..	..	..	..	..	..	57	..
3 ..	28	4	7	..	1	..	1	..	2	..	..	..	..	1	..	..	44	..
4 ..	28	7	2	3	..	..	..	..	..	..	..	..	..	..	..	..	40	..
5 ..	5	3	4	1	..	3	..	..	..	..	..	..	..	..	..	..	16	..
6 ..	9	7	5	..	..	..	..	..	..	..	..	..	..	..	..	..	21	..
7 ..	10	4	2	1	1	1	..	..	..	..	..	..	..	..	..	..	19	..
8 to 14 ..	30	4	2	1	..	..	..	..	..	..	2	..	..	..	..	..	39	..
15 to 21 ..	3	..	1	1	1	..	..	..	..	..	..	..	..	..	..	..	6	..
22 to 28 ..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..
29 to 35 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
36 to 42 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
43 to 49 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
50 and over ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
Total ..	154	55	48	1/22	12	8	6	1	3	1	2	..	..	2	..	..	1/314	0·31
Percentage death rate ..	..	..	..	4·5	..	..	..	..	..	..	..	..	..	..	..	..	..	..

TABLE VII-b.

Classification according to number of wounds and lateness of arrival.

Numerators—Deaths. Asiatics. *Denominators*—Cases.
Institute.

Days late	Number of wounds																Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	15	16	17 and over		
0 ..	2	20	38	17	20	7	4	3	2	..	1	..	..	2	1	1	118	*Nil.*
1 ..	10	58	69	52	51	14	10	5	2	1	2	2	..	2	..	..	278	,,
2 ..	6	11	25	11	8	7	1	..	..	..	..	..	..	..	..	..	69	,,
3 ..	..	7	14	9	2	2	2	..	..	..	..	..	..	..	..	..	36	,,
4 ..	4	14	13	11	9	2	2	..	..	..	..	..	..	..	..	..	55	,,
5 ..	3	8	8	4	4	8	..	1	..	..	..	..	..	..	..	..	36	,,
6 ..	1	5	2	2	3	2	..	..	..	..	..	..	..	..	..	..	15	,,
7 ..	1	8	5	3	4	1	..	..	..	..	1	..	..	..	..	..	23	,,
8 to 14 ..	..	19	10	5	5	2	2	..	1	1	..	..	1	..	..	..	46	,,
15 to 21 ..	1	1	4	4	1	2	2	..	..	..	..	..	..	..	..	..	15	,,
22 to 28 ..	..	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	2	,,
29 to 35 ..	..	4	1	2	..	..	..	..	..	..	..	..	..	..	..	..	7	,,
36 to 42 ..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	,,
43 to 49 ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	,,
50 and over.	..	2	5	1	..	..	..	..	..	..	..	..	..	..	..	..	8	,,
Total ..	29	158	195	121	107	47	24	9	5	2	4	2	1	4	1	1	710	*Nil.*
Percentage death rate.									*Nil.*									

TABLE VII-c.

Classification according to number of wounds and lateness of arrival.

Numerators—Deaths. Asiatics. *Denominators*—Cases.
Centres.

Days late	Number of wounds															Total	Percentage death rate
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14 & over		
0 ..	10	26	42	27	31	8	11	3	1 6	1	..	..	..	..	1	..	1/166	0·60
1 ..	14	3/105	223	1/171	2/145	1/62	37	1/19	12	5	9	1	2	3	..	1	8/809	0·98
2 ..	12	2/128	264	1/177	3/154	2/42	1/49	19	1 21	1/3	4	..	2	2	..	4	11/881	12·5
3 ..	17	1/109	1/209	1/170	116	59	45	19	18	6	5	1	1	..	1	4	3/780	0·38
4 ..	10	1/86	159	2/122	3/97	47	1/20	6	15	5	1/6	..	..	..	1	3	8/577	1·3
5 ..	8	55	90	1/47	1/46	27	12	6	10	2	2	1/1	4	..	2	5	3/317	0·94
6 ..	8	43	1/60	46	1/39	1/15	15	1/5	2	2	1	1/1	..	..	..	..	5/237	2·1
7 ..	9	39	2/44	36	1/32	7	4	7	3	2	5	1	2	..	..	..	3/191	1·5
8 to 14 ..	37	95	129	1/77	2/72	21	17	1/8	8	1/6	1	2	..	1	..	..	5/474	1·05
15 to 21 ..	3	1/24	42	27	19	7	3	2	..	2	1	..	..	..	..	..	1/330	0·76
22 to 28 ..	4	4	15	1	4	2	..	..	1	..	1	2	..	..	..	..	34	..
29 to 35 ..	1	11	1/14	1/7	5	3	4	1	..	1	..	..	..	..	..	..	2/47	4·2
36 to 42 ..	..	..	3	1	..	..	..	..	..	..	..	..	..	..	..	..	4	..
43 to 49 ..	1	3	2	3	2	..	1	..	..	1	..	..	..	..	..	..	13	..
50 and over.	2	7	10	5	3	4	..	..	..	..	..	1	..	..	..	..	32	..
Total ..	136	8/735	5/1,306	8/917	13/765	4/304	2/218	3/95	2/96	2/36	1/35	2/10	11	6	5	17	50/4,692	1·07
Percentage death rate. ..		1·0	0·38	0·87	1·8	1·3	0·91	3·1	2·1	6·1	2·8	20·0	..	..	..	..		

TABLE VIII.

Classification according to position and depth of wounds, and interposition of clothing.

Numerators—Deaths. Europeans. *Denominators*—Cases.

Institute.

Deep Bare	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
+ +	4	..	3	..	1	..	8	*Nil.*
+ −	2	..	..	..	..	..	2	,,
− +	2	..	9	..	..	..	11	,,
− −	5	..	..	..	..	..	5	,,
Total ..	13	..	12	..	1	..	26	*Nil.*
Percentage death rate.				*Nil.*				

TABLE VIII-a.

Classification according to position and depth of wounds, and interposition of clothing.

Numerators—Deaths. Europeans. *Denominators*—Cases.

Centres.

Deep Bare	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
+ +	16	..	30	4	1/7	..	1/57	1·7
+ −	9	..	8	6	1	..	24	..
− +	19	1	194	1	2	..	217	..
− −	12	1	2	1	..	..	16	..
Total ..	56	2	234	12	1/10	..	1/314	0·31
Percentage death rate.	..	..	..	..	10·0	..	..	..

TABLE VIII-b.

Classification according to position and depth of wounds, and interposition of clothing.

Numerators—Deaths. Asiatics. *Denominators*—Cases.
Institute.

Deep	Bare	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
+	+	242	..	100	9	12	5	368	*Nil.*
+	–	57	3	17	2	..	..	79	,,
–	+	123	1	39	2	..	..	165	,,
–	–	91	1	4	2	..	..	98	,,
Total ..		513	5	160	15	12	5	710	*Nil.*
Percentage death rate.		..	..	..	..	..	..	..	..

TABLE VIII-c.

Classification according to position and depth of wounds, and interposition of clothing.

Numerators—Deaths. Asiatics. *Denominators*—Cases.
Centres.

Deep	Bare	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
+	+	6/943	34	7/490	1/109	12/109	4/62	30/1,747	1·7
+	–	449	62	1/131	2/39	12	3	3/696	0·43
–	+	8/965	28	3/453	1/38	1/35	2/16	15/1,535	0·97
–	–	1/521	79	1/90	13	9	2	2/714	0·28
Total ..		15/2,878	203	12/1,164	4/199	13/165	6/83	50/4,692	1·07
Percentage death rate.		0·52	..	1·03	2·01	7·8	7·2	..	..

TABLE IX.

Classification according to position of wounds and lateness of arrival.

Numerators—Deaths. *Denominators*—Cases.

Europeans.

Institute.

Days late	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
0 ..	3	..	..	..	..	..	3	*Nil.*
1 ..	3	..	4	..	1	..	8	*Nil.*
2 ..	5	..	..	..	..	..	5	*Nil.*
3 ..	..	..	1	..	..	..	1	*Nil.*
4 ..	2	..	3	..	..	..	5	*Nil.*
5 ..	..	..	3	..	..	..	3	*Nil.*
6 ..	..	..	1	..	..	..	1	*Nil.*
7 ..	..	..	..	..	..	..	..	..
8 to 14 ..	..	..	..	..	..	..	..	..
15 to 21 ..	..	..	..	..	..	..	..	..
22 to 28 ..	..	..	..	..	..	..	..	..
29 to 35 ..	..	..	..	..	..	..	..	..
36 to 42 ..	..	..	..	..	..	..	..	..
43 to 49 ..	..	..	..	..	..	..	..	..
50 and over ..	..	..	..	..	..	..	..	..
Total ..	13	..	12	..	1	..	26	*Nil.*
Percentage death rate.	..	..	..	..	..	..	..	..

TABLE IX-a

Classification according to position of wounds and lateness of arrival.

Numerators—Deaths. *Denominators*—Cases.

Europeans.

Centres.

Days late	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
0 ..	8	1	27	2	1/1	..	1/39	2·5
1 ..	10	1	15	4	2	..	32	..
2 ..	12	..	40	3	2	..	57	..
3 ..	5	..	38	..	1	..	44	..
4 ..	5	..	32	..	3	..	40	..
5 ..	7	..	9	..	..	..	16	..
6 ..	4	..	16	..	1	..	21	..
7 ..	3	..	15	1	..	..	19	..
8 to 14 ..	1	..	36	2	..	..	39	..
15 to 21 ..	..	..	6	..	..	..	6	..
22 to 28 ..	1	..	..	..	..	..	1	..
29 to 35 ..	..	..	..	..	..	..	..	..
36 to 42 ..	..	..	..	..	..	..	..	..
43 to 49 ..	..	..	..	..	..	..	..	..
50 and over ..	..	..	..	..	..	..	..	..
Total ..	56	2	234	12	1/10	..	1/314	0·31
Percentage death rate.	..	..	..	..	10·0	..	..	..

TABLE IX-b.

Classification according to position of wounds and lateness of arrival.

Numerators—Deaths. *Denominators*—Cases.

Asiatics.

Institute.

Days late	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
0 ..	84	1	25	4	2	2	118	*Nil.*
1 ..	210	1	57	4	6	..	278	*Nil.*
2 ..	48	1	19	..	..	1	69	*Nil.*
3 ..	26	1	7	1	1	..	36	*Nil.*
4 ..	37	1	16	..	1	..	55	*Nil.*
5 ..	25	..	10	1	..	..	36	*Nil.*
6 ..	9	..	6	..	..	..	15	*Nil.*
7 ..	17	..	5	..	..	1	23	*Nil.*
8 to 14 ..	33	..	7	4	1	1	46	*Nil.*
15 to 21 ..	10	..	5	..	..	..	15	*Nil.*
22 to 28 ..	1	..	..	1	..	..	2	*Nil.*
29 to 35 ..	4	..	2	..	1	..	7	*Nil.*
36 to 42 ..	1	..	1	..	..	..	2	*Nil.*
43 to 49 ..	..	..	..	..	..	..	..	*Nil.*
50 and over ..	8	..	..	..	..	..	8	*Nil.*
Total ..	513	5	160	15	12	5	710	*Nil.*
Percentage death rate.			*Nil.*					

TABLE IX.-c.

Classification according to position of wounds and lateness of arrival.

Numerators—Deaths. *Denominators*—Cases.

Asiatics.

Centres.

Days late	Leg	Trunk	Arm	Multiple	Face	Multiple face	Total	Percentage death rate
0 ..	101	9	42	7	1/7	..	1/166	0·60
1 ..	2/493	32	3/194	43	3/27	20	8/809	0·98
2 ..	3/509	45	2/196	31	3/29	3/11	11/881	1·25
3 ..	1/458	38	1/190	1/32	37	25	3/780	0·38
4 ..	4/364	13	1/140	1/27	2/25	8	8/577	1·3
5 ..	1/197	15	1/81	1/14	7	3	3/317	0·94
6 ..	1/148	13	1/58	9	2/6	1/3	5/237	2·1
7 ..	1/103	12	51	1/12	1/8	5	3/191	1·5
8 to 14 ..	1/285	17	1/143	11	1/13	2/5	5/474	1·05
15 to 21 ..	86	5	1/33	3	1	2	1/130	0·76
22 to 28 ..	20	..	11	3	..	..	34	..
29 to 35 ..	1/33	1	1/9	3	..	1	2/47	4·2
36 to 42 ..	1	..	2	..	1	..	4	..
43 to 49 ..	8	..	4	1	..	..	13	..
50 and over ..	12	3	10	3	4	..	32	..
Total ..	15/2,878	203	12/1,164	4/199	13/165	6/83	50/4,692	1·07
Percentage death rate.	0·52	..	1·03	2·01	7·8	7·2	1·8	..

TABLE X.

Deaths from Hydrophobia amongst persons treated in 1930.

Europeans.

Institute.

Serial Number	Case Number	Number of days from commencement of treatment to onset of symptoms	Sex	Age in years	Biting animal		Number and position of wounds					Wounds				Number of days late	Duration of illness in days	Interval between bite and death in days	Treatment			
					Kind	Class	Leg	Trunk	Arm	Face	Total	Deep	Extensive	Bare skin	Uncauterised				Class of cases	Type	Duration in days	Serial Number
←										— Nil —												→

TABLE X-a.

Deaths from Hydrophobia amongst persons treated in 1930.

Europeans.

Centres.

Serial Number	Case Number	Number of days from commencement of treatment to onset of symptoms	Sex	Age in years	Biting animal		Number and position of wounds					Wounds				Number of days late	Duration of illness in days	Interval between bite and death in days	Treatment			
					Kind	Class	Leg	Trunk	Arm	Face	Total	Deep	Extensive	Bare skin	Uncauterised				Class of cases	Type	Duration in days	Serial Number
1	326	40	M.	8	Dog	A	..	..	..	3	3	+	—	+	—	0	2	42	IV	16	14	

TABLE X-b.

Deaths from Hydrophobia amongst persons treated in 1930.

Asiatics.

Institute.

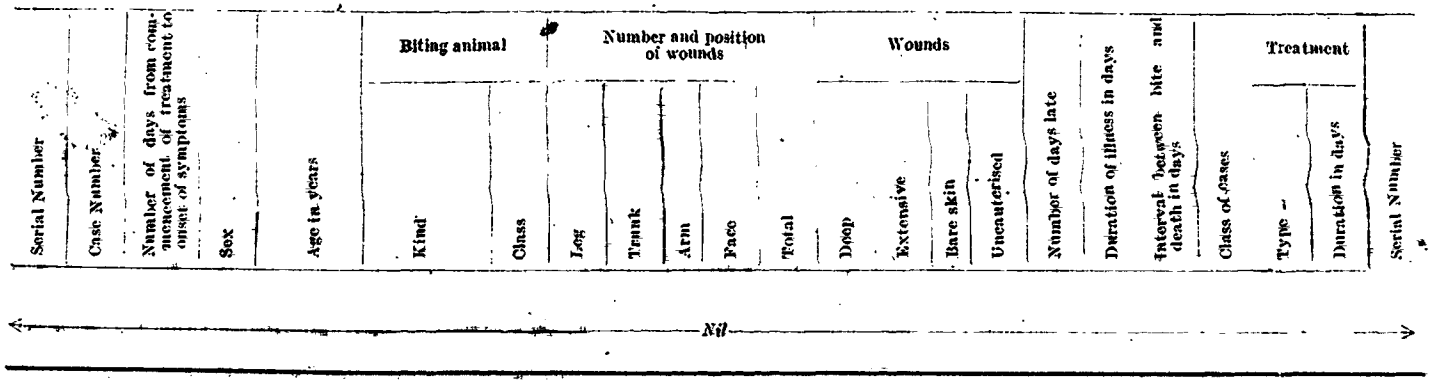


TABLE X-c.

Deaths from Hydrophobia amongst persons treated in 1930.

TABLE

Deaths from Hydrophobia amongst

Asiatics.

Centres.

Serial Number	Case Number	Number of days from commencement of treatment to onset of symptoms	Sex	Age in years	Biting animal		Number and	
					Kind	Class	Leg	Trunk	Arm
1	188	1	M.	10	Dog. ..	C	..	..	2
2	755	3	M.	12	Dog. ..	D	..	..	2
3	20	8	F.	25	Dog. ..	C	..	..	3
4	191	12	M.	6	Dog. ..	C	..	..	..
5	147	9	M.	12	Dog ..	C	..	5	3
6	13	13	M.	12	Dog ..	C	..	..	..
7	15	13	M.	6	Dog ..	C	..	..	..
8	14	14	F.	7	Dog ..	C	..	..	2
9	362	14	F.	16	Jackal ..	C	..	..	..
10	189	16	F.	45	Dog ..	C	..	..	..
11	208	17	M.	15	Dog ..	C	..	..	..
12	192	17	M.	5	Dog ..	C	..	..	5
13	64	17	M.	40	Jackal ..	C	2	..	..
14	10	18	F.	17	Dog ..	C	..	..	1
15	136	18	M.	40	Dog ..	C	..	..	6
16	166	18	M.	8	Dog ..	C	1	..	..
17	91	19	M.	50	Jackal ..	C	..	..	..
18	322	20	M.	6	Jackal ..	C	..	..	..
19	180	21	F.	15	Dog ..	B	3	..	..
20	230	21	M.	12	Dog ..	D	..	..	..
21.	294	21	M.	12	Dog ..	C	..	..	4
22	89	22	M.	3	Dog ..	C	..	..	..
23	27	22	M.	18	Dog ..	B	..	7	3
24	214	25	M.	62	Dog ..	B	..	..	..
25	203	27	M.	2	Dog ..	C	..	..	1
26	383	27	M.	5	Dog ..	C	..	..	3
27	175	30	M.	2	Dog ..	A	..	..	..
28	77	34	M.	3	Dog ..	A	..	..	6
29	118	34	F.	55	Jackal ..	C	3	..	..
30	11	35	M.	40	Jackal ..	C	..	..	2
31	418	37	M.	16	Dog ..	C	4	..	..
32	136	38	M.	20	Dog ..	C	3	..	..

X-c.

persons treated in 1930.

position wounds		Wounds				Number of days late	Duration of illness in days	Interval between bite and death in days	Class of cases	Treatment	
Face	Total	Deep	Extensive	Bare skin	Uncauterised					Type	Duration in days
..	2	+	—	+	+	31	2	34	IV	16	2
..	2	—	—	+	+	10	1	14	II	14	2
..	3	+	—	—	+	15	1	24	IV	12	8
3	3	+	—	+	+	10	1	23	III	16	12
..	8	+	—	+	+	8	2	19	II	14	7
6	6	+	—	+	—	4	2	19	IV	12	14
11	11	+	—	+	+	6	4	23	IV	16	14
3	5	+	—	+	+	6	3	23	IV	16	14
4	4	+	—	+	+	7	2	23	IV	16	14
4	4	+	—	+	+	8	2	26	IV	16	14
1	1	+	—	+	+	4	3	24	IV	16	14
4	9	—	—	+	+	2	4	23	IV	16	14
..	2	+	+	+	+	6	3	26	IV	16	14
..	1	+	—	+	+	1	2	21	III	12	14
2	8	+	—	+	+	2	4	24	IV	16	14
3	4	+	—	+	+	2	2	22	IV	16	14
5	5	+	—	+	+	2	3	24	IV	16	14
5	5	+	—	+	+	2	1	23	IV	16	14
..	3	+	—	+	+	4	3	28	III	16	14
7	7	+	—	+	+	1	3	25	IV	16	14
3	7	+	—	+	+	8	4	33	IV	16	14
1	1	+	—	+	+	1	2	25	IV	16	14
..	10	+	—	—	—	4	2	28	III	12	14
4	4	+	+	+	—	1	1	27	IV	16	14
..	1	—	—	—	—	20	1	28	II	14	7
..	3	—	—	—	—	1	2	30	III	16	14
8	8	+	+	+	+	0	3	33	IV	16	14
..	6	+	+	+	—	2	1	37	IV	16	14
..	3	—	—	+	+	30	2	66	II	14	7
..	2	+	—	+	+	30	1	66	III	12	14
..	4	—	—	+	+	4	4	45	II	14	7
..	3	—	—	+	+	2	2	42	II	14	7

TABLE

Serial Number	Case Number	Number of days from commencement of treatment to onset of symptoms	Sex	Age in years	Biting animal		Number and		
					Kind	Class	Leg	Trunk	Arm
33	364	38	M.	3	Dog ..	C	..	..	1
34	40	39	M.	10	Dog ..	C	1	..	1
35	38	39	F.	22	Dog ..	C	2	..	..
36	123	48	M.	25	Jackal ..	C	4	..	..
37	107	53	M.	60	Jackal ..	C	6	..	5
38	414	53	F.	50	Jackal ..	C	..	..	3
39	441	54	M.	18	Dog ..	C	3	..	..
40	64	58	M.	50	Jackal ..	C	..	..	3
41	870	64	M.	50	Dog ..	C	4	..	..
42	172	66	M.	32	Jackal ..	C	..	..	..
43	1	69	M.	40	Dog ..	C	..	..	6
44	7	81	M.	75	Dog ..	C	..	..	4
45	95	82	F.	42	Dog ..	C	4	..	..
46	87	86	M.	13	Jackal ..	D	4	..	..
47	158	90	M.	3	Dog ..	C	..	..	..
48	125	95	M.	13	Dog ..	C	4	..	..
49	822	96	M.	45	Dog ..	C	3	..	..
50	517	108	F.	60	Dog ..	C	1	..	..
51	86	120	M.	67	Dog ..	C	1	..	..
52	198	126	M.	9	Dog ..	C	1	..	1
53	180	130	F.	8	Dog ..	C	..	..	5
54	11	170	M.	4	Dog ..	C	..	..	4

X.c—*contd.*

position wounds		Wounds				Number of days late	Duration of illness in days	Interval between bite and death in days	Class of cases	Treatment	
Face	Total	Deep	Extensive	Bare skin	Uncauterised					Type	Duration in days
..	1	—	—	+	+	2	3	43	II	14	7
..	2	+	—	—	—	7	2	44	III	12	14
..	2	+	—	+	+	7	3	49	III	16	14
..	4	+	—	+	—	2	6	56	III	16	14
..	1	—	—	+	+	5	3	61	III	16	14
..	3	—	—	+	+	4	4	61	III	16	14
..	3	+	—	+	+	13	3	70	III	16	14
..	3	—	—	+	+	3	4	65	II	14	7
..	4	—	—	+	+	4	3	71	II	14	7
4	4	+	—	+	+	6	4	76	III	16	14
1	7	+	—	+	+	6	1	76	III	12	14
..	4	+	—	+	+	8	1	90	III	12	14
..	4	+	+	+	+	2	2	86	IV	16	14
..	4	—	—	+	+	4	3	93	III	12	14
1	1	—	—	+	—	2	6	98	IV	16	14
..	4	—	—	+	+	1	2	93	II	14	7
..	3	—	—	+	+	5	4	105	II	14	7
..	1	—	—	+	+	4	4	113	II	14	7
..	1	—	—	—	—	3	5	128	II	14	7
..	2	+	—	+	—	3	5	134	III	16	14
..	5	+	—	+	—	1	4	135	IV	16	14
..	4	+	—	+	+	5	2	177	III	12	14

TABLE

Classification by the animal which bit,

Numerators—Deaths.

Animal	Institute								
	Number treated			Percentage to total			Death rate per cent.		
	Europeans	Asiatics	Combined	Europeans	Asiatics	Combined	Europeans	Asiatics	Combined
Dog ..	23	699	722	88·5	98·5	98·1	..	..	..
Jackal ..	..	..	..	..	..	..	..	..	..
Horse ..	..	1	1	..	0·14	0·14	..	..	..
Monkey ..	..	3	3	..	0·42	0·4	..	..	..
Cat ..	1	4	5	3·8	0·56	0·67	..	..	..
Man ..	2	1	3	7·6	0·14	0·4	..	..	..
Deer ..	..	..	..	..	..	..	..	..	..
Tiger ..	..	..	..	..	..	..	..	..	..
Donkey ..	..	..	..	..	..	..	..	..	..
Panther ..	..	..	..	..	..	..	..	..	..
Goat ..	..	..	..	..	..	..	..	..	..
Calf ..	..	..	..	..	..	..	..	..	..
Bullock ..	..	..	..	..	..	..	..	..	..
Bear ..	..	..	..	..	..	..	..	..	..
Wolf ..	..	..	..	..	..	..	..	..	..
Fox ..	..	..	..	..	..	..	..	..	..
Mungoose ..	..	1	1	..	0·14	0·14	..	..	..
Unknown ..	..	1	1	..	0·14	0·14	..	..	..
Total ..	26	710	736	..	..	..	..	..	..

XI.

scratched or licked the patient.

Denominators—Cases.

Centres								
Number treated			Percentage to total			Death rate per cent.		
Europeans	Asiatics	Combined	Europeans	Asiatics	Combined	Europeans	Asiatics	Combined
1/294	38/4,273	4,567	93·6	91·6	91·2	0·34	0·88	0·85
..	12,352	352	..	7·5	7·0	..	3·4	3·4
1	23	24	0·31	0·49	0·47	..	..	..
5	11	16	1·5	0·23	0·31	..	..	..
13	10	23	4·1	0·21	0·45	..	..	..
..	7	7	..	0·15	0·13	..	..	..
..	4	4	..	0·09	0·07	..	..	..
..	3	3	..	0·06	0·05	..	..	..
..	3	3	..	0·06	0·05	..	..	..
1	..	1	0·31	..	0·01	..	..	..
..	1	1	..	0·02	0·01	..	..	..
..	1	1	..	0·02	0·01	..	..	..
..	1	1	..	0·02	0·01	..	..	..
..	1	1	..	0·02	0·01	..	..	..
..	1	1	..	0·02	0·01	..	..	..
..	1	1	..	0·02	0·01	..	..	..
..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..
1/314	50/4,692	51/5,006	..	..	..	..	..	..

Digitized with financial assistance from the Government of Maharashtra on 11 July, 2017

TABLE XII.

Number of patients treated by months.

	Institute			Centres			Institute and centres combined		
	Europeans	Asiatics	Total	Europeans	Asiatics	Total	Europeans	Asiatics	Total
January ..	3	66	69	19	436	455	22	502	524
February ..	5	54	59	19	332	351	24	386	410
March ..	3	65	68	26	387	413	29	452	481
April ..	..	78	78	26	361	387	26	439	465
May ..	..	67	67	26	415	441	26	482	508
June ..	3	39	42	27	391	418	30	430	460
July ..	..	63	63	23	365	388	23	428	451
August ..	5	29	34	25	359	384	30	388	418
September ..	2	60	62	28	400	428	30	460	490
October ..	..	67	67	27	379	406	27	446	473
November ..	3	50	53	31	442	473	34	492	526
December ..	2	72	74	37	425	462	39	497	536
Grand Total ..	26	710	736	314	4,692	5,006	340	5,402	5,742

TABLE XIII.

Statement showing brains submitted and examined for rabies.

Serial number	Animal	Number of brains examined	Positive	Negative	Unfit for examination
1	Dogs	150	99	45	6
2	Goats	2	1	1	..
3	Jackal	1	..	1	..
4	Deer	1	1	..	..
	Total ..	154	101	47	6

BOMBAY : PRINTED AT THE GOVERNMENT CENTRAL PRESS.